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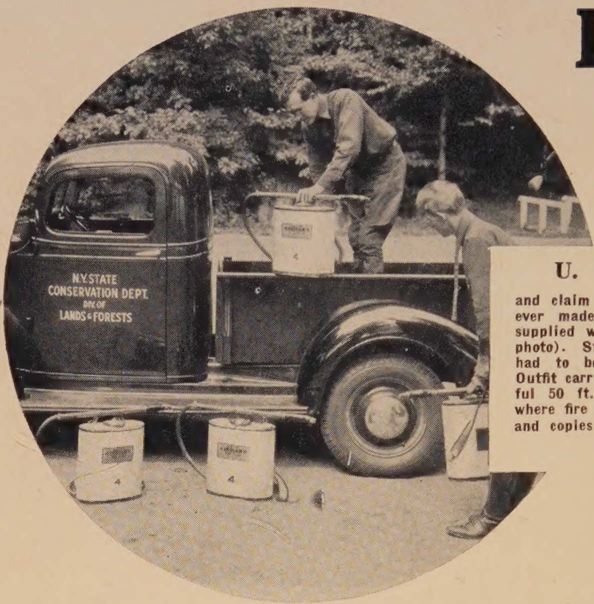

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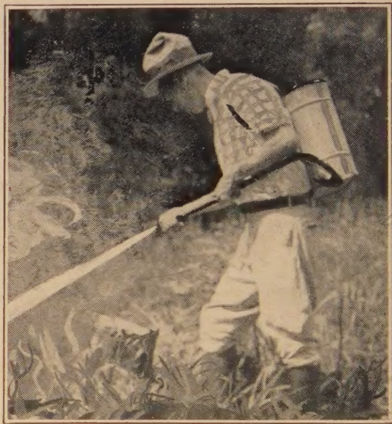

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JOURNAL OF FORESTRY

Vol. 36 APRIL, 1938 No. 4

The Society is not responsible, as a body, for the facts and opinions advanced in the papers published by it. Editorials are by the Editor-in-Chief unless otherwise indicated and do not necessarily represent the opinion of the Society as a whole.

EDITORIAL

The Lumber Industry Looks At Forestry

DURING the past twenty years the lumber industry has changed almost completely its notion of the attributes, the potentialities, and the social utility of the forest. There are many indications that this metamorphosis is not yet complete. There are hopeful signs that it will develop a still nicer conception of its public responsibilities. There is even some basis for the belief that when the industry eventually gets its stride that its forest practices may surpass those of public agencies. This change will not be precipitous—it cannot be. It will be slow and deliberate. There are many difficulties to overcome. There will be many disappointments, some failures, some backsliders. At the moment, the lumber industry, in common with other industries, is facing many perplexing problems. Heavy investments, increasing wages, reduced hours, changing and decreasing markets, and mounting taxes harass the lumber industry along with the others. In addition, the lumber industry faces certain problems peculiar to itself. Not the least important of these is the attitude of the public toward it. Official and unofficial spokesmen of the public devote a prodigious amount of time and energy broadcasting the destruction wrought by the lumber industry, and of the social and economic consequences of this destruction.

Much of what these spokesmen say is true—or at least has been true. There have been destruction, waste, human and economic wreakage, desolation—and for what purpose? Quite largely that a vigorous growing nation might have cheap lumber. To be sure, the average lumberman did not engage in the lumber business because he had altruistic objectives. He was after profits. Unfortunately for him, however, the expected profits did not always accrue; often he lost his shirt. The public always won, and, strangely enough, always lost. It had the advantages of cheap lumber—it inherited an economic desert.

But why are conservationists so inclined to look backwards? Today is certainly of greater interest than yesterday—tomorrow of greater interest than today. Sunsets are often beautiful; they are always pensive. Sunrises are often somber; except for the doomed, they are always assuring. To be sure, the past is the best guide to the future, but it does not necessarily follow that the future will conform to the past.

There now appears to be a general awakening in the lumber industry to the fact that timber is a crop. No longer do progressive lumbermen regard timber merely as a God-given resource to be exploited with no consideration for the future. In every important forest region in the country, the Northeast, the Lake States, the South, the Rocky Mountain region, and the Pacific Coast the change can be noted. Precisely how far the lum-

ber industry is ready to go, indeed, how far it can go, is not yet clear. The important thing is that it is "going."

Probably the most rapid advance in industrial forestry is being made in the South. Recently the allied pulpwood and pulp and paper industries of the South adopted a set of principles involving forest cutting in a manner which will maintain and build up the forest growing stock, the employment of the necessary technical personnel, and more effective fire control. In the Northeast several large paper companies are operating on a sustained yield basis; in the Lake States at least one large lumber company is cutting its forests on a more conservative selective logging basis than public agencies; in the Rocky Mountain region and in the Pacific Coast area forest practice conferences are being held in order to develop better forest practices among timberland owners. In western Washington and Oregon alone operators expended during 1937 over $800,000 for forest protection and fire fighting. These are but a few of the indications of the awakening of the lumber industry to the possibilities of better forest practices.

Critics of private forest ownership point to the fact that only a relatively small percentage of the total area in private ownership are adequate measures taken to safeguard the productivity of the forest. This is patently true. However, all important movements have small beginnings. Some critics of private forest practices seem to question the sincerity of the private owner. Some insincerity there may be, but an operator who has invested thousands of dollars—yes, perhaps even hundreds of thousands of dollars of his own or of his company's money—in following better forest practices is entitled to more consideration than having his sincerity questioned. Such criticism is superficial, unscholarly, and sterile.

The ability of the timber industry to cope fully with the many problems confronting it without additional public cooperation and without some form of public regulation, however, may well be questioned. Public cooperation and even public regulation imply joint responsibilities. The lumber industry has stated clearly its position regarding more extensive public cooperation. Broadly speaking, it wants more effective protection against fire, fungous diseases, and insect pests; it wants relief from burdensome taxation; it wants forest credits; it wants reasonable public measures to insure the markets for timber; and it wants assurance that it will not be forced to meet excessive competition from publicly owned forests. Considering all the factors involved, these wants do not appear intemperate or excessive, but there is little evidence that the public will accede to them hastily.

The lumber industry is not enthusiastic about public regulation, yet it is becoming reconciled to the fact that it probably will be regulated. Spokesmen for the lumber industry indicate that the industry would not fear regulation that would start from the practical experience of the lumberman in the woods and develop from that point. The experience gained under the conservation code and forest practice rules of the N.R.A. seems to offer at least one solution. Despite their unpopularity in certain quarters, and despite certain limitations, these rules nevertheless embodied the best judgment and intelligence, both of the timber operator and the professional forester. In some forest regions these rules are still being followed on a voluntary basis. The official desinence of the forest practice rules of the N.R.A. would therefore appear to be a sound point of departure. If public regulation is to be successful it must be sound, economic, and workable. A heavy duty rests upon those who are given the high privilege to counsel those responsible for enacting national legislation. May great wisdom, sound knowledge, and good judgment be their's!

RADIO COMMUNICATION SYMPOSIUM

THE use of radio communication in forest administration has been increasing greatly in recent years. Its spread has been the result of an early belief by foresters that the radio had exceptional possibilities as a new tool in forest fire control. This eagerness to adapt the radio to forestry work received considerable support from radio technicians and manufacturers of radio equipment, until today the radio has become an almost indispensable supplement to the telephone in many organizations.

As may be supposed, the federal government, particularly the U. S. Forest Service, pioneered in this field. From 300 sets used principally in the Pacific Northwest in 1933, radio use on National Forests increased to 1,800 stations in 1936; and more than 2,300 stations are now in use. The Forest Service maintains a radio laboratory in Portland, Oregon. Of the ten National Forest regions, California leads in the use of radio with more than 600 sets of the short wave or ultra high frequency type. The North Pacific Region of Oregon and Washington has 500 sets, and the Middle and Lake States region has 300 forest radios. All other regions, including Alaska and Puerto Rico, are making use of radio communication.

Forest developed radio sets now are being used by other federal agencies, including the Indian Service, the National Park Service, the Bureau of Lighthouses, the Navy, the Bureau of Reclamation, the Biological Survey, the National Agricultural Research Center, the Weather Bureau, and the Tennessee Valley Authority.

In addition to the use made of the radio by the federal agencies, many state and private forestry organizations have developed communication systems to fit their individual needs. And at least one county forest fire control system has done likewise.

The papers presented in this symposium indicate the extent to which foresters have brought radio into the forest protective and administrative fields.

Radio as a National Forest Protection Tool.—A. G. Simson.

The Use of Radio by a State Forest Protection Agency.—Walter J. Quick, Jr.

Radio In County Forest Fire Control.—H. J. Malsberger.

Radio Communication Adapted to Fire Protection on Private Lands.—William M. Oettmeier.

RADIO AS A NATIONAL FOREST PROTECTION TOOL

By A. G. SIMSON[1]
U. S. Forest Service

IN general good telephone communication is preferable to good radio communication. However, each has its place in the forest communication system. Where the use is not heavy, where telephone line maintenance is difficult or expensive, and in areas of heavy static, such as where a telephone line covers territory with radical changes in elevation, the radio may furnish more satisfactory and dependable communication than the telephone. On the other hand, for 24-hour service and where it is necessary to have community outlets, as in cities and villages, the telephone is usually more useful than the radio.

It has been the experience of the Forest Service that in almost every instance radio service is a supplement to the telephone and does not replace it. Although the Forest Service has over 2,000 radio stations there has been no slowing up in the rate of telephone line construction. In fact, if anything, it has been augmented.

In general, forest protection radio communication requirements are: communication with mobile units, such as patrolmen, smoke chasers and fire suppression crews; communication with emergency detection forces; communication nets on large fires; communication where it is impossible or impracticable to build and maintain telephone lines; and communication with units whose location is very temporary, such as C.C.C. camps and spike camps.

Most of the apparatus for these services must be portable. Some of it must be extremely light-weight, notably that for smoke chasers and patrolmen who may already be overloaded with tools and other equipment. The equipment used by larger units, such as fire crews, need not be so light since truck or pack horse transportation is usually available. Equipment which is moved infrequently, such as that installed on lookouts, is not so subject to rigid space and weight restrictions as is that employed in the more mobile services. All the equipment must be ruggedly built and as nearly fool-proof as possible. Normally sets are used by untrained men, many of them temporary employees hired only for the duration of a fire.

Early in the history of radio development for forest protection communication it became apparent that best results could be obtained by placing foresters, who also had a technical knowledge of radio, in charge of the development work; rather than depending on radio engineers who were not familiar with forest protection problems. The project seemed to be one not so much of radio research as of adapting known radio principles and circuits to the very specialized and exacting requirements of forest protection communication. Obviously, the men who by years of training and experience had detailed knowledge of the Forest Service organization, and the many different conditions of topography, fire hazards, fire control methods, and the rigorous conditions under which the equipment would be used, were best equipped to determine and develop the kind of tool needed. One of the contributing factors leading to this conclusion was the inability to find satisfactory commercial equipment suitable for the work and the inability to locate a commercial organization with sufficient knowledge of forest protection commu-

[1]Radio engineer, North Pacific Region.

nication requirements to develop satisfactory apparatus. Accordingly, the Forest Service was forced to develop its own radio apparatus. There follows a description of the most widely used types of radio transmitter-receivers which have been produced as a result of this development program.

Type PF Radiophone

The type PF radiophone transmits and receives both voice and code. It weighs about 15 pounds, and has a rated working range of about 10 miles on voice and 20 miles when code is used.

The PF was designed primarily for use by smokechasers and patrolmen where reasonably compact and portable voice communication is required. These sets are often carried on fire trucks by road and train crews, rangers, and other traveling forest officers, and in some instances are made a part of fire outfits of 25-man size and larger.

PF Kitbox

The PF kitbox is a small chest containing heavier batteries than are regularly furnished with the PF radiophone and a half-wave antenna for semi-permanent installation. A compartment is also provided to house the PF radiophone. The kitbox, batteries, and antenna, exclusive of the PF radiophone, weigh about 35 pounds.

The PF kitbox, together with the PF radiophone, was primarily designed to serve secondary lookouts (lookout firemen), small fire crews, and small construction or maintenance crews. Where used on lookouts, the half-way antenna is permanently installed at the lookout station and the PF radiophone plugged into the batteries contained in the PF kitbox. Then, should the lookout need to take his radio set to a fire, it is only necessary to unplug the PF kitbox battery cable, drop the set into the PF radiophone bag, which already contains batteries and a short antenna, and he has a complete 15-pound voice set ready to go.

Another illustration of use of this equipment is the case of a small road camp that had a PF set as the only means of communication. In camp the men used the permanently installed half-wave antenna and the kitbox batteries, but during bad fire-weather periods, when working some little distance from camp, they carried the 15-pound radiophone outfit on the job each morning and set it up to keep contact with the fire detection organization during the day. Each evening they brought the set into camp, where it was again hooked up for the evening and early morning schedules. This saved holding the men in camp during dangerous fire weather.

Type SPF Radiophone

This unit (Fig. 1) employs the same transmitter as the PF but the receiver section is entirely new. It includes a sensitive 5-tube superheterodyne which requires less skill to operate than is necessary with the PF receiver. It can be operated on the same batteries as the type PF; that is, with "portable" or "kitbox" batteries. "Portable" batteries are not recommended, however, except in emergency, as the battery drain is greater than on the PF.

The SPF unit is suitable for "stand-by" operation with "kitbox" or heavy-duty batteries, as it has a built-in loudspeaker. It has a definitely greater communication range than the PF, and is recommended to take the place of the PF where back packing is unnecessary, or at most, limited to short distances. The SPF, with carrying bag, and portable batteries, weighs about 20 pounds. With kitbox and both "kitbox" and "portable" batteries the weight is approximately 58 pounds. The SPF kitbox is similar to the PF kitbox. The type SPF is recommended for field use in preference to the type PF wherever

Fig. 1.—Type SPF radiophone with kitbox. This unit is the backbone of the Forest Service radio communication.

the additional weight of the type SPF is not objectionable.

Type M Radiophone

The type M radiophone (Fig. 2) has been consolidated and simplified so that the transmitter, receiver, and loudspeaker are all housed in one field case. It is a voice and code transmitter-receiver, weighing about 175 pounds. The rated working range is about 50 miles. The receiver is a highly selective commercial superheterodyne. The type M operates on 110-120 volt, 60 cycle A.C., ordinary commercial current; not on batteries or other direct current power. It may be plugged into any light socket or outlet where alternating current (A.C.) is available. Where 110-120 volt A.C. is not available, either of the two portable generator units listed below may be used as a source of power for the type M.

The M radiophone has been especially designed for communication with the field from supervisors' headquarters and central equipment depots, and for use as a central communication station on large project fires.

Type M sets may be expected to cause interference over a radius of several hundred miles, and should never be used except where lower powered sets will not furnish satisfactory communication. Where M sets are used they should be adjusted to emit the minimum power that will give satisfactory service.

Portable Generators

Two portable generator units are commercially available for use where commercial (A.C.) electric current is not available. Each consists of a self-excited, self-regulated A.C. generator driven by a Briggs & Stratton gas engine, which will supply current to operate the type M radiophone and any ordinary A.C. receiver of the short-wave or all-wave type. The 500-watt unit weighs about 90 pounds and the 700-watt unit weighs about 105 pounds. The 700-watt unit is recommended because of greater capacity and dependability.

High Frequency Type I

The type I radiophone is a complete transmitter-receiver intermediate in power between the SPF and the M radiophone. It can only be operated from 6-volt storage batteries—not dry batteries—or 110-volt alternating current. The entire unit is mounted in a steel cabinet identical in size and shape to that of the 1937 model C, type M radiophone. In fact, the type I radiophone is primarily a modfied M set for storage battery operation.

The receiver of the type I is a highly sensitive superheterodyne operating from the same storage battery source as is used to supply the transmitter. A vibrator type power supply similar to that in automobile radio receivers is employed in this receiver, thus eliminating the necessity for operating the transmitter dynamotor while receiving. The receiver does not use plug-in coils or band switching, and covers only the regular range of Forest Service frequencies, namely 2,900 to 3,500 kc. A loud speaker is mounted in the front panel of the unit for standby service. A storage compartment for all accessories, such as dynamotor, antenna, halyards, phones, microphone, and telegraph key, is located in the rear of the cabinet.

The power rating of the transmitter is approximately 8 watts as compared to 2 watts for the type SPF and 20 watts for the type M, and should provide a consistent working range of 25 or 30 miles and transmission up to distances of 200 miles or more under favorable conditions.

Current drawn from the storage battery is approximately 3 amperes for the receiver and 20 amperes for the transmitter. The transmitter employs the "push-to-talk" system, the same as that in the type M. The 20-ampere current is drawn only during the time the microphone button is depressed for actual voice transmission.

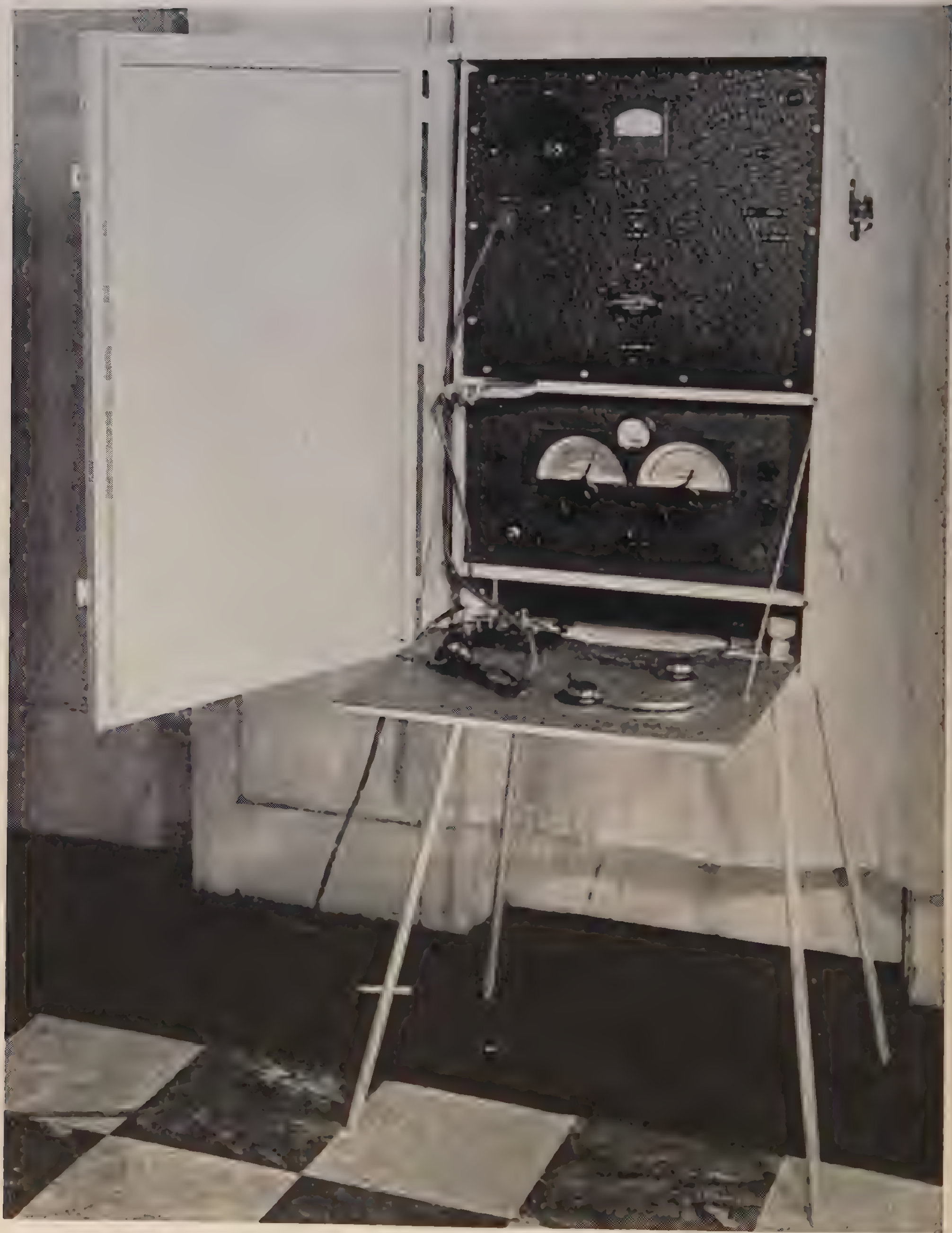


Fig. 2. Forest Service type Service M radiophone. Used at base camp on large fires.

The power output of the type I may be increased at any time to a maximum value of 20 watts by the substitution of a dynamotor of higher voltage and current rating. Such an increase in dynamotor rating will, of course, result in an increased drain from the storage battery of approximately 30 amperes. Thirty amperes is a very heavy battery load and is not recommended except in unusual instances.

When installed in remote locations, storage batteries for the type I radiophone may be kept charged by means of any one of several commercially available gasoline-driven charging plants. Such plants weigh from 40 to 50 pounds and consume approximately ½ pint gasoline per hour.

In addition to its use at permanent and semi-permanent locations, the type I should fill an existing need for communication from fire trucks and other large vehicles.

Ultra-high Frequency Radio Equipment

Ultra-high frequencies (UHF) have the limitation of being good only over optical or nearly optical ranges. For example, usually it is not possible to communicate between two points when the optical path between the antennas at the respective stations is obstructed by a hill or mountain. But where it is possible to use UHF equipment it offers many advantages over the ordinary short-wave radio. There is practically no fading or static; the equipment can be made light and compact; the antenna is short—about 15 feet; and receiver battery drain is small enough so that "stand-by" operation of battery receivers is possible. By using one frequency for transmitting and another for receiving, a pair of stations may be operated "duplex," that is, talk and receive simultaneously.

UHF lends itself admirably to linking up emergency lookouts with the regular lookout system. It has also been used successfully for communication nets on large project fires.

Two-way communication with moving vehicles is also possible.

UHF operation is still quite new. New tubes, parts, and technique are being developed almost daily. In order to keep step with this progress and take advantage of new developments in circuits and parts, the Forest Service is making sweeping revisions in its ultra-high frequency equipment at relatively frequent intervals. Therefore, the following description of Forest Service UHF radiophones may be out of date shortly with respect to equipment details, though the same general types herein listed will be continued in a gradually improved form.

Type T Radiophone Transmitter-Receiver (UHF)

The type T radiophone transmits and receives voice only. It weighs from 50 to 100 pounds, depending on the type of batteries used. Rated working range is about 100 miles over optical paths. The set is designed for stand-by operation, and has a built-in loudspeaker. The details of the existing set are not given due to the fact that the current model is now considered obsolete and will soon be replaced by an improved model.

Type S Radiophone Transceiver (UHF)

The type S radiophone transreceiver (Fig. 3) transmits and receives voice only. It weighs about 8 pounds. The rated working range is about 50 miles over optical paths. With antennas close to the ground over level ground the range may be reduced to no more than 3 or 4 miles. This set will not work duplex, as the same circuit is used for both transmitting and receiving. It has been used by smokechasers and by scouts and fire chiefs on large fires. Its principal features are its portability and the quickness

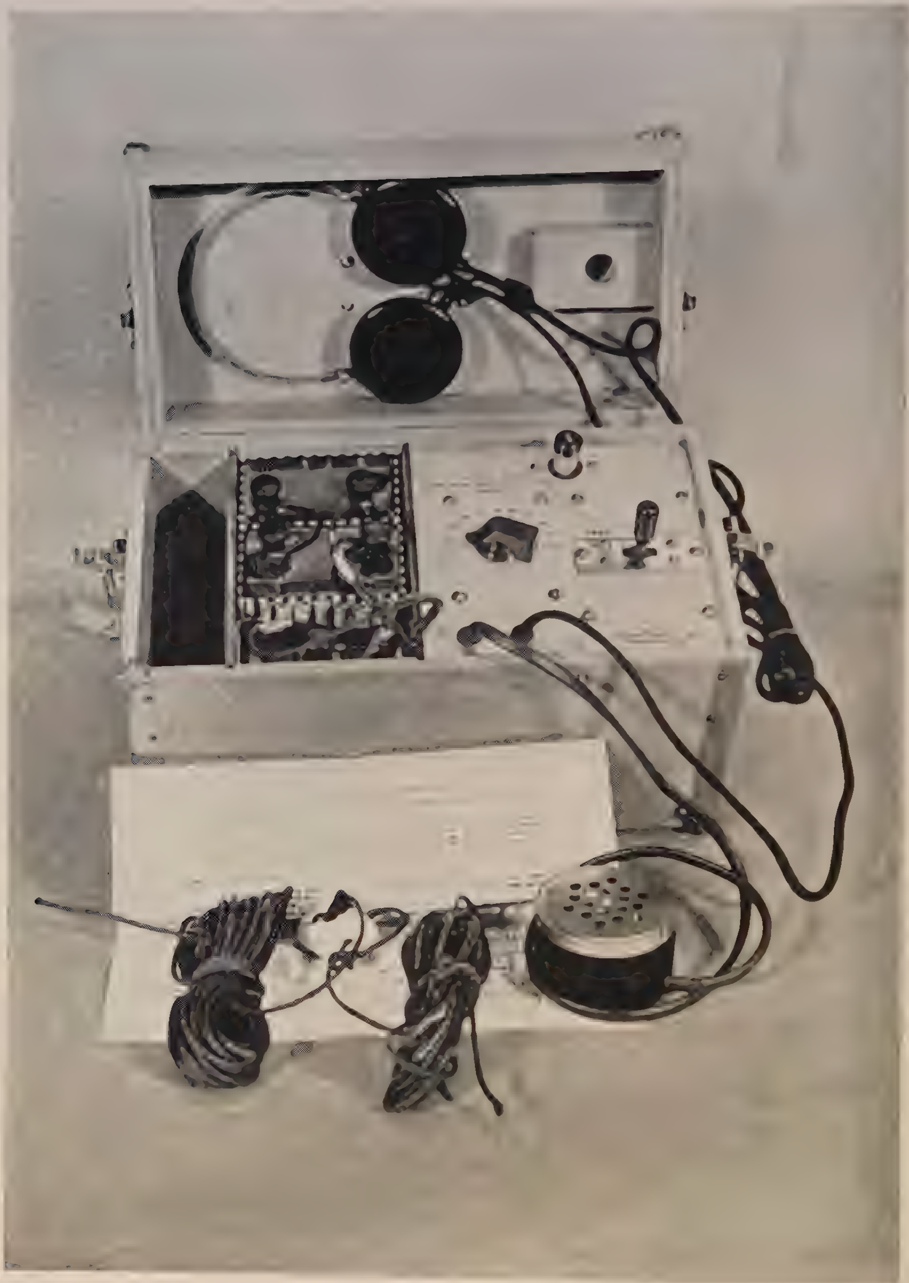


Fig. 3.—Forest Service type S ultra high frequency radiophone. Used in portable short-range communication.

with which it may be put in operation. Type S sets have occasionally been used for two-way communication with moving vehicles.

Ultra-high Frequency Type SV

The type SV has greater transmitting power and numerous refinements over the type S. The front panel of this unit is 6x10 inches and the depth 5 inches. The weight will be about 16 pounds, complete with all accessories including built-in speaker. Although the transmitting and receiving circuits are electrically independent, provision has been made for "simplex" operation only as in the type S.

The transmitter power output of the unit is approximately 1 watt as compared to 1/10 watt for the type S. The circuit employed is similar to that of the type S with the addition of an electrical filter for improving quality of voice reception. Ballast tubes have been used in the type SV instead of the fixed resistors used in the type S. These ballast tubes eliminate the necessity of filament rheostats and automatically compensate for the gradual reduction in A battery voltage as the batteries wear out, thus materially increasing the service life of the A batteries.

An additional audio stage has been included to increase the volume to that necessary to operate a loud speaker, thus allowing the SV to operate stand-by and in many instances serve as a direct substitute for the Type T radiophone. Although the loud speaker will only be supplied on special request, headphones will always be included with the set.

All batteries will be attached to the set by means of a plug and socket arrangement, thus allowing the light-weight portable batteries to be removed and heavy duty batteries plugged in for permanent or semi-permanent installations. In order to increase the transmitting power it has been necessary to increase the "B" battery voltage on the SV to 135 volts.

Type A Radiophone (UHF)

The type A radiophone has been especially designed to meet Forest Service requirements in airplane use. It can be installed in practically any type of plane without special tools or mechanical skill; will communicate plane-to-ground over limited distances even in unshielded planes. Weight of complete radiophone, including dynamotor but exclusive of storage battery, is about 40 pounds. It operates from a 6-volt storage battery or from the storage batteries regularly incorporated in most airplanes.

Type U Radiophone

This is an A.C. operated ultra-high frequency radiophone transmitter-receiver especially intended for central station use, such as at central fire dispatcher offices. The unit is 19 inches wide, 4 feet 9 inches high, and 12 inches deep. The approximate shipping weight is 300 pounds. It has an output of about 20 watts. No antenna is furnished with the unit, as the antenna for each installation should be built at the location where the set is to be used to conform to the physical limitations of the location. Wherever the outlying stations to be communicated with are all in one general direction from the U set (an arc of 180 degrees or less) directional or "beam" antennas should be used.

The outstanding feature of this unit is its simplicity of operation. When a call is received on the stand-by loudspeaker it is only necessary to pick up the handset in order to answer. Lifting the handset automatically turns on the transmitter.

The U set communicates with the types T, S, SV, A and U radiophones and works "duplex," that is, talks and receives simultaneously with the type T and other U sets.

Radio Operating Channels

The selection of the proper radio frequencies or channels for the particular

communication job is important. Because the communication is with very low powered equipment, and much of it is over rough terrain, and because of the space limitations both of the set itself and the antenna, it has been found that high frequency sky wave radiation is desirable. It has been our experience that sky wave radiation fills in the valleys and gets over mountains with a higher signal level than does direct or ground wave radiation. In other words there is less "shadow effect." The disadvantage of the high frequencies where sky wave radiation is depended upon is that the signal strength varies materially from hour to hour, day to day, and year to year. Therefore, it is desirable to select those high frequencies least susceptible to these variations. Engineering data indicate that the 3,000 to 4,000 kilocycle frequencies are the most consistent of the high frequencies in this respect.

Where communication is limited to short distances and over an optical or nearly optical path, ultra-high frequencies of the order of 30 megacycles (30,000 kc.) or higher are usually more desirable than the high frequencies. This is because in the ultra high frequencies there is practically no fading, little if any static, and the antennas are short, about 15 feet or less in length. Moreover, it is a relatively simple matter to install simple directive or "beam" antenna systems.

Non-federal government forest protection agencies cannot at present take full advantage of these phenomena because of the lack of available radio channels. Frequency allocation records indicate that the only high frequency on which allocations have been made is the Special Emer-

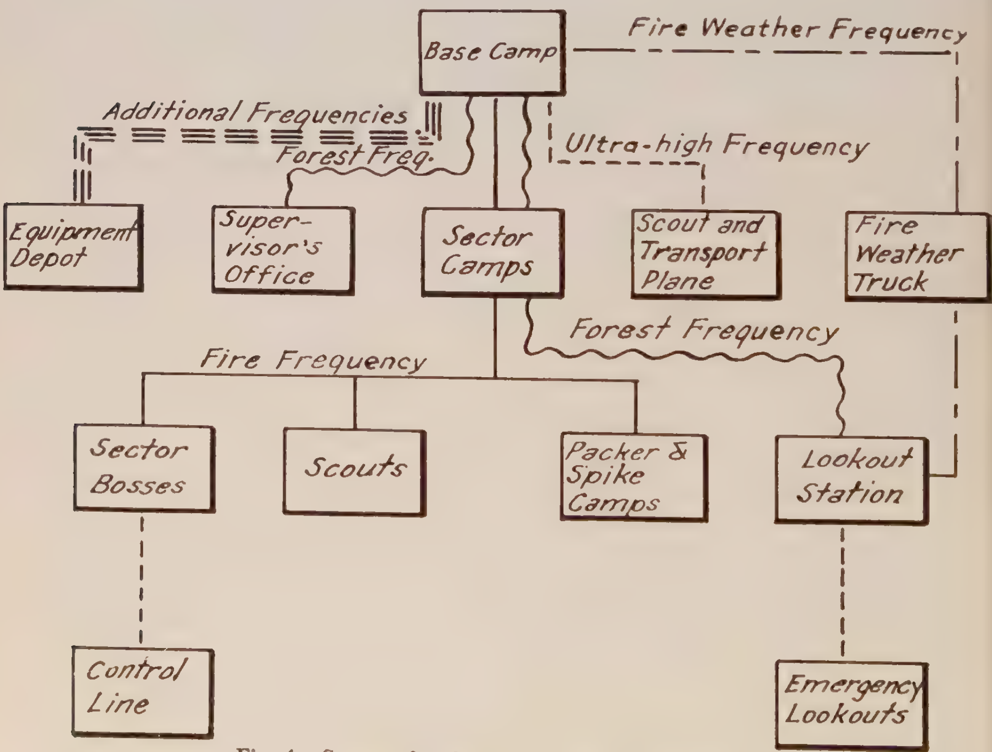


Fig. 4.—Suggested radio net for use on large fires.

gency frequency 2,726 kilocycles. This single frequency can only accommodate a limited number of licensees, such as flood control agencies, power companies, and forest protection agencies, because of destructive mutual interference. Probably because of the dearth of high frequencies most of the non-federal forest protection agencies using radio have been issued licenses in the ultra high frequency band between 30 and 40 megacycles. These licenses are experimental and revocable without notice or hearing.

It is obvious that there can be no intensive general use of radio by state, private, and association forest protection agencies unless an adequate number of radio channels is made available.

Some Random Observations

Several years' experience with radio in forest protection work has led to the conclusions that it is better to sacrifice some electrical efficiency than to have too many switches, dials, and meters on the sets. A multiplicity of controls in the hands of unskilled men gives rise to more equipment failures and generally less satisfactory results than do too few controls.

The state of the radio art is advancing so rapidly that the obsolescence in radio equipment is comparable to that in automobiles. The Forest Service has adopted a 5-year depreciation period. In the interests of economy nothing is spent on beautifying the sets as it is felt that rapid obsolescence makes such attention unjustifiable.

Radio appears to have a great deal of what one forester terms "sex appeal." In many instances it is necessary to subdue over-enthusiastic tendencies to use too much radio and in the wrong places.

Another tendency which has to be curbed is that of wide-spread, unnecessary, and uncontrolled tinkering with the radio apparatus. The answer is, of course, centralized development where adequate laboratory equipment can be made available rather than scattered experimentation among untrained men without adequate facilities for scientific work.

Organizations that are breaking into the field of radio usually find it necessary to employ professional radio engineers. Generally, this is a desirable move so long as there is no tendency on the part of the radio engineer, in his desire to produce the last word in an equipment masterpiece electrically, to make the communication job fit the radio set rather than the radio apparatus fit the job. Hence the radio engineer should be required thoroughly to acquaint himself with forest protection methods and problems in order that the equipment he develops or secures be best suited to meet the forest protection communication needs.

THE USE OF RADIO BY A STATE FOREST PROTECTION AGENCY

By WALTER J. QUICK, JR.
Maryland Department of Forestry

THE author claims no special knowledge of the peculiarities of radio communication, but hopes by means of this article to make known to those interested in development of communication facilities, the experiences and conclusions resulting from four years of trial and operation of ultra high frequency radio by the Maryland Department of Forestry. Recognizing that there is a real danger of misinterpreting the meaning of as yet little understood radio phenomena, he nevertheless believes from the limited experience in Maryland that a much greater use of radio by forestry and conservation agencies is fully justified. The more agencies that can participate in a conservative and studied development of high frequency equipment, with frequent exchange of information relative to the activity of each, the sooner radio will become a simplified and efficient means of regular and rapid communication wherever forest business requires.

Our knowledge and progress in Maryland results from the operation of two stations in 1934, five stations in 1935, six stations in 1936 and eight stations in 1937, totaling 10,355 station hours of activity through September 30, 1937. Although we have conducted tests in all sections of the state, our actual communication has been limited to the central part where the largest volume of fire activity is experienced, where closer supervision of activity from headquarters can be given, and where the concentrated advantages of multiple stations can be of the greatest good. Obviously, to distribute radio stations at great distances beyond their communication range from each other in remote sections would not get results; a station must be able to contact many other stations to be of greatest service. Thus, a gradual establishment of a communication network within one protection district has been the objective, after which expansion into other districts will follow. Of the stations now in operation, one is a central dispatching station which directs the activity of all the others, four are operated in lookout towers, and three are automobile stations used in smoke investigation and fire fighting, to which another automobile station will be added in the near future. It is estimated that 220,000 acres, or approximately one tenth of the forested area of the state, is covered by the present eight stations. Possibly 100 stations of various types will be required to give satisfactory communication for all forestry emergencies.

Radio communication has not supplanted the use of telephone where commercial lines are available. In any forest protection organization which depends to great extent upon the cooperation of public spirited citizens, the telephone must remain the means for emergency contact outside of the organization while radio can fill the gaps where communication has not existed, and where busy lines and overburdened switchboards make telephone contacts too slow between the remote lookout stations in a rapidly functioning triangulation system. Upon the rapid interchange of information between fire control stations by means of radio, telephone lines are released for a more rapid and effective contact of local cooperators than is possible when lines must be tied up in greatly delayed long distance calls to remote towers and administrative offices. Use of telephone, as a supplement to and in conjunction with radio, becomes an even more productive tool in the control

of fires, as the information to be conveyed by telephone is available soon enough to be of much greater value.

In Maryland, as in most other states, the forest protection work is divided geographically into a number of protection units or districts, within each of which all personnel and activity is directed from a central headquarters. It is the intention to tie all forested sections of each district, as well as all fire control stations within the district, to local headquarters by means of radio. In some instances, it may be necessary to relay messages through stations at lookout towers or other contact stations to headquarters or to establish special pickup receivers in remote locations connected to headquarters by means of telephone line. This will enable free and easy communication among fire control forces of the district, thus encouraging the ready exchange and comparison of fire information. Since in many protection districts the various fire control stations are on different commercial telephone exchanges, it is necessary to incur a toll charge for each telephone call with little possibility for free interchange of ideas between all sections of the district. This results in a tendency to restrict the use of telephone, while a more intensive intercommunication would be to advantage. This becomes possible where a district radio network ties the various stations and forested areas together.

Upon establishment of a radio network in adjacent protection districts, it probably will become desirable to provide radio contact between adjacent district headquarters and with state headquarters. This is a development for the future, but it is contemplated that this can be accomplished by means of automatic receiver-transmitter relays or by the use of lower radio frequency for operation between widely separated headquarters sites. Without some such arrangement, many of the advantages gained through use of radio in one protection unit could not be extended in mutual aid to its neighboring districts without great delays and unwarranted expense.

What has been done in Maryland can be duplicated or improved upon by other forest protection organizations without any radio experience, and the initial developments can be as modest as the agency's resources may direct. A single transmitter could be assembled from parts costing from \$50 to \$100 by a competent radio technician and operation could commence with one-way transmission upon the purchase or construction of a \$35 receiver. However, if a larger development can be financed, it is probably preferable that a number of commercially constructed two-way sets be obtained and placed in operation under competent supervision by a licensed technician. A consideration of the procedure and methods used in Maryland may be instructive to those considering a similar development.

Compliance with Federal Regulations

The pioneer developments by the U. S. Forest Service in the use of radio for forest protection were made under certain exemptions from regulation by the Federal Communications Commission. Many agencies have envied the ability of the Forest Service to put stations on the air without station licenses and by personnel without operator licenses, for this privilege is not extended to other than federal agencies. Further than this, the federal agencies are permitted to share among themselves the use of certain medium wave frequency channels which are not available to non-federal agencies, and which have certain advantages for long distance communication. By mutual agreement, the federal agencies are supposed to regulate their stations so as to confine their transmissions to certain selected radio frequencies, but some of the equipment operated by certain agencies has not been capable of accurate frequency control particularly by non-technical person-

nel. However, this freedom from regulation should not be interpreted by nonfederal agencies as an indication that they can operate in a similar manner. Federal statute prescribes very severe penalties for operation of transmitters without licenses, without licensed operators or off an assigned frequency. Maryland's radio developments have, therefore, been along quite different lines from the U. S. Forest Service and in strict compliance with the regulations of the Federal Communications Commission.

In realization of the necessity for complying with federal regulations, the earliest development of Maryland forestry radio was supervised by a radio trade school graduate who had experience as an amateur operator and in commercial service as a ship station operator. Other agencies should also be able to locate available trade school graduates who possess or can qualify for a second or first class radio operator's license. Frequently, experienced amateurs who can qualify for a commercial license will accept temporary employment. It is, nevertheless, important to locate as well trained a technician as can be afforded as the ability of this employee will decide much of the success and progress of the undertaking. However, his time need not be charged exclusively to radio development, as the right kind of employee can also function as a towerman, dispatcher, or in some other capacity in forest protection by which he can be in contact with radio operation.

Appropriate forms are available from the Federal Communications Commission to apply for station construction permits, station licenses, or in renewing licenses. It is advisable to file applications well in advance of the date when the authorization is desired as a number of revisions in the applications may be necessary before authority is granted and rather long delays can be expected before permits or licenses are issued. An elapse of from ten to twelve weeks is likely to occur from the date on which construction permit is requested until the station license is available for operation.

Federal regulations require that ultra high frequency stations with not over 50 watts of power must be operated by persons possessing third class radiotelephone operator's licenses, or by persons without any operator's licenses if a chief operator with a second or first class radiotelephone license listens in and monitors the frequency of the stations under his supervision. The latter method has permitted the operation of Maryland stations for the most part without licensed operators, and that method appears best adapted to forestry radio stations due to the seasonal nature of the work, a rapid turnover in part-time employees, and the necessity for using emergency employees with little education in meeting severe fire conditions. Thus, the radio technician with second or first class license serves as dispatcher or towerman and supervises the operation of the other stations with authority to order any of them off the air if trouble develops. However, an employee who is able to read and write can easily learn the necessary radio laws and regulations so as to qualify for a third class license, which is an advantage in case the chief operator is ill or not constantly available, but in spite of this possibility a chief operator with a superior license is essential in operating stations during personnel changes.

During the first few years of operation, very few Maryland employees qualified for third class licenses, and a high percentage of those who attempted the examination on radio laws and regulations failed to qualify. However, during the current year, Maryland's chief operator gave the employees operating stations personal instruction in the necessary information with the result that all operators, with exception of recent additions, are now licensed third class operators. Although the licensing of operators within a

district network is not a necessity if a licensed chief operator is available, it is an advantage to be able to license operators for certain remote stations which are too distant to be supervised by the chief operator. This enables the establishment of new stations in an adjacent protection district or in a distant section of the initial network beyond the supervision of the chief operator. Some few employees can be expected to show proficiency in station operation, repair and construction with consequent ability to qualify for advanced licenses, enabling supervision of stations in new networks as radio communication is extended into other protection districts.

The Federal Communications Commission will make a selective allocation of the radio frequencies above 30,000 kilocycles to specific public services on October 13, 1938. The use of the assigned ultra high frequencies by the various services, including forestry, has been and will be entirely experimental until the selective allocation becomes effective, at which time the present use of frequencies will be changed. Forestry communication in Maryland has been conducted under four experimental frequency assignments which are 31,600, 35,600, 38,600, and 41,000 kilocycles. The communication on these frequencies has been for the purpose of determining the usefulness of the ultra high frequencies for a proposed new radio service classification to be designated by the Communications Commission as the forestry service. The Commission has recently announced official recognition of the value of radio communication in forestry development and conservation work and in the suppression of forest fires. Ten frequencies will, therefore, be assigned to the exclusive use of the newly designated forestry service to be used on a shared basis by the various licensees. The Commission has indicated that contiguous states will, necessarily, have to cooperate in the use of frequencies to reduce interference to each other. Rules and regulations governing this new class of service are to be promulgated by the Commission well in advance of the effective date of the allocation. The ten frequencies which will be available to forest protection agencies are 30,940, 31,340, 31,580, 31,820, 35,420, 35,740, 35,940, 39,420, 39,740, and 39,940 kilocycles.

At present, the Commission requires that the licensee of each station shall maintain the assigned frequency within a tolerance of .05 per cent for stations operating on frequencies above 30,000 kilocycles, and further that some provision be made for measurement and periodic checking of the station frequency to insure operation within the permitted tolerance. The most simple transmitters of conventional design are of the modulated oscillator type which are subject to considerable frequency fluctuation due to changes in temperature, humidity, line voltage, and other factors. By proper design and operation under favorable conditions with periodic checking, it is possible to operate such stations within the permitted tolerance, but it is the policy of the commission to refuse to authorize equipment when it appears that in the current state of the radio art more stable stations could be provided.

Although it has not been expected that the Commission will prohibit the use of equipment already licensed, prior to the selective allocation of frequencies to specific services, it has been advisable for licensees to make refinements in their equipment from time to time, rebuilding transmitters when increased radio knowledge indicated that improvements were possible. While the Commission has desired that licensees improve their transmitters, particularly through refinements that assured operation more exactly on the assigned frequencies, they have felt that it would be premature for a licensee to provide crystal control of station frequency prior to the selective allocation.

An investment in crystal control, which is the present best known means for maintaining the frequency of a station, would be wasted upon change of assigned frequency at the time of selective allocation, because crystals are especially adapted to a designated frequency at considerable expense and cannot be changed. Upon the effective date of the allocation of the ultra high frequencies to specific services, crystal control will be desirable, if not a necessity, in order to prevent transmitters from causing interference to adjacent services, as the frequency assignments of services adjacent to forestry are only 40 kilocycles removed. Unrelated transmitters with rather broad signals operating on frequencies only 40 kilocycles apart are likely to cause side band intereference to each other. For this reason it is entirely possible that the Commission may reduce the permitted frequency tolerance to .02 per cent, in which case crystal control will be required. Any licensee should, therefore, be prepared to add crystal control at that time and to make other necessary improvements from time to time as required through rules of the Commission. This can be accomplished with the minimum inconvenience if a competent radio technician serves as chief operator for the licensee.

Adequacy of Low Power for Voice Transmission

In the familiar low frequency commercial broadcasting stations it is generally known that rather high power is essential to adequate coverage and clear reception. Broadcast stations of less than 100 watts are hardly known, and stations of the 250 and 500 watts class are little known beyond their local communities. Stations of 1,000, 2,500 or 5,000 watts are very common, and the better stations are frequently of 10,000 watts or higher power. Therefore, when it is realized that the smaller ultra high frequency transmitters can send satisfactory signals under favorable conditions with as little as one-tenth watt of radiated energy, one of the great advantages of ultra high frequency operation becomes apparent. With low power, a cheap source of electrical energy is possible, with attendant advantages in small component transmitter parts and consequent greater portability. Where transmitting conditions are unfavorable, power as high as 100 watts may be used, but for ordinary purposes this is considered excessive.

In transmitting between two fixed points where operating conditions seldom, if ever, vary, it is possible to use directional antennae so placed as to send the maximum signal towards the receiving station, with the result that very low power is needed. However, in ordinary forestry communication, at least one end of the transmitting and receiving circuit varies as to location and distance from the station to be contacted, with a consequent wide variation in operating conditions and obstacles to be overcome. These variables make it desirable that more power be used than is necessary under ideal conditions.

Subject to limitations which will be described later, transmitters of various power radiation, operating on 35,600 kilocycles, have given average operating ranges in Maryland of approximately the following: 6 watts cover 5 to 6 miles; 8 watts cover 8 to 9 miles; 10 watts cover 10 to 11 miles; 15 watts cover 12 to 13 miles; and 45 watts cover 17 to 18 miles. However, it should be recognized that these are average working distances between tower and mobile stations, and that between two fixed stations, with elevated antennae, much greater distances are possible at the signal strength indicated. Thus, it is seen that comparatively low power is sufficient for the distances listed. However, it should be borne in mind that, for some other frequency and for other sections of the country, different average

ranges can be expected, although the difference should not be great for minor variations.

For miniature transmitters, the highly portable transceiver and low powered directional sets that radiate up to three watts of power, dry cell batteries have been used in all sets of this type that have been considered or tested for use in Maryland. Some of the smaller transmitters, that are suitable only for operation over relatively short distances between permanent locations, can operate on multiple dry cells such as are used in a flashlight, while the transceivers and larger transmitters of this class require larger dry cells of special design which are relatively expensive when it is considered that annual replacement is desirable. It is not considered economical nor practical to operate stations radiating more than 2 or 3 watts of energy, from dry cell batteries.

A six-volt wet cell battery, such as used for automobile ignition, which can be frequently and regularly recharged, is capable of operating transmitters radiating up to 10 watts of power. Small dynamotors are operated from the wet cell battery which generate several hundred volts for operating the transmitter. This draws heavily on the battery while transmitting, or approximately 10 to 14 amperes which is equivalent to lighting the automobile headlights, but the battery drain is very moderate while only the receiver is turned on. Continuous transmission for an extended period would rapidly run the battery down, but if transmission is intermittent, with long periods of listening in between transmissions, an automobile or wind driven generator has opportunity to restore the battery's energy. Long operation of stations from wet cell batteries should not be considered unless a means for battery charging is provided.

Stations of almost any desired power rating can be operated where commercial electrical current is available, where gasoline engine driven generators are installed, or where water power generators can be provided. Surprisingly efficient, dependable and economical air-cooled gasoline generators can be obtained for little more than the cost of a short commercial line installation, which makes it possible to operate powerful fixed station transmitters in remote wilderness areas.

In the early studies of the characteristics of ultra high frequency radio communication, it was discovered that signals were absorbed or interrupted by objects that intervened between the sending antenna and the receiving antenna, and since many of the early experiments were conducted with low powered sets, it was believed that the path of ultra high frequency radio energy was limited to an optical line of sight. However, from operation and extensive tests in Maryland, that generality does not appear to be strictly true, as greater power seems to have the effect of sending signals into depressions below the line of sight and in many cases to locations behind ridges where lower power could not reach. In all such cases, the sending antenna must be at a high location from which point the path of energy can either follow a gentle arc across the intervening barrier or can be reflected from higher ground or objects beyond the receiving antenna.

In all cases where the receiving antenna moves beyond the horizon of the sending antenna, all signal reception is completely eliminated. Therefore, it is believed that, for all practicable purposes, the maximum range of any ultra high frequency antenna is limited by its horizon, and the ability of a transmitter to send signals into depressions and behind ridges closer than the actual horizon of its antenna depends upon the amount of power in the signal radiated. Of course, it is realized that signals may at times be reflected from very distant stations by way of the sky in what is frequently referred

to as skip distance effect, but such signals are neither dependable nor consistently strong enough to be considered as a regular means of communication. It is important in planning for ultra high frequency stations to realize that the horizon of an antenna is greatly increased by increasing its elevation above the earth, and that it is, therefore, important in gaining distance that at least one end of the transmitting circuit be at a high elevation. It is for this reason that a network of lookout towers located on the most commanding elevations available is ideal for development of an ultra high frequency radio system. However, it is important to realize that in communicating with mobile and portable stations close to the ground, it is necessary for the headquarters or control station to be equipped with a high tower or to depend upon other tower stations to contact the stations close to the ground.

Portability of Ultra High Frequency Equipment

The comparatively small size of the component parts of ultra high frequency equipment is a decided advantage insofar as portability and cost of parts is concerned. Inasmuch as considerably less power is used and lower voltages are brought into play than on longer wave length equipment, smaller and less complicated parts are needed. A comparison may be drawn in that the transformer for voice modulation at broadcast station WLW, one of the most powerful in use, is about the size of a two story house, while the same part in a ten watt ultra high frequency transmitter may easily be put in one's pocket. Also, the size of the coils and condensers for tuning short wave length equipment is about one-twenty-fifth of the size of those used by regular broadcast stations. Tubes recently developed for use in receivers and low powered transmitters operating on the ultra high frequencies are exactly the size and shape of an acorn and lend themselves to construction of very small pack sets which for stunt purposes have been built into the crown of a man's hat.

While it has been pointed out that ultra high frequency radio parts are very small when compared to long or medium wave equipment, it should be recognized that there is a definite relationship between the power of a station and its size, weight, and consequent portability. Some of the midget transmitters of very low power weigh little more than a pound including dry cell battery power supply, but the more capable transceivers and portable code transmitting stations weigh up to 20 or 30 pounds including batteries and power supply. The weight of the batteries and power supply unit is the factor that usually determines portability; transmitters of stronger signal output require larger batteries and heavier transformers in the assembly.

In automobile transmitters, an increase in weight to 30 or 40 pounds is brought about through addition of a wet cell battery, which is heavier than dry cells, and a small but heavy dynamotor operated from the battery for generating sufficient voltage to produce a much stronger signal than can be produced from dry cells. Although such a dynamotor could be operated from dry cells, it would quickly exhaust the batteries without possibility of restoring their energy as could be done in the use of an automobile wet cell battery. In the case of radio equipment at fixed stations, where portability and source of electrical energy are not important considerations, the weight of equipment is greatly increased in producing stronger signal radiation. In such installations, equipment weighing as much as 150 or 200 pounds may be used, to which may be added as high as several hundred pounds for gasoline engine electric generator or other source of electric current. The importance of portability in field radio sets for forestry work is of

course important, but it should be fully appreciated that increase in portability through reduced weight also means reduced signal power with consequent reduction in communication range.

The usual conception of a radio transmitting system is a number of huge towers on which are suspended great networks of innumerable wires. While the factor of height is decidedly important in obtaining good coverage with ultra shortwave equipment, a forest protection agency usually has this advantage in the prominent location and height of its lookout towers where a large number of its radio stations can be located.

The antenna system used for forestry communication in Maryland, at fixed stations operated at 35,600 kilocycles, is known as a matched impedance "J" and consists merely of a straight piece of wire 19 feet 9 inches long mounted by means of standoff insulators along a vertical mast, and from the bottom of which an additional piece of the same wire extends 6 feet 7 inches, paralleled by a second wire separated 4 inches from the first wire by insulated spreaders. From the bottom ends of these parallel wires the feed line consisting of a twisted pair of wires of known impedance connects to the transmitter proper.

For mobile stations, a straight rod 6 feet 7 inches long, which is usually telescopic, is used for an antenna and may be mounted on rear bumper of the automobile or to advantage on higher parts of the vehicle, as on a bracket fastened to the front door hinge. These mobile antennae are usually fed by means of a concentric feeder line which consists of a solid wire spaced exactly in the center of a length of 3/8 or 1/2 inch metal tubing or hollow metallic cable by means of small insulated discs through the center of which the wire runs. This concentric line is about the best and simplest feeder line known and incurs comparatively low losses in transferring energy to the antenna. The small size and simplicity of these antennae arrangements are among the greatest advantages of ultra high frequency radio as they make possible instant and constant communication with mobile stations and add to the ease of operation of portable equipment.

From the foregoing, it should be apparent that ultra high frequency radio equipment has almost unlimited possibilities for adaptation to forestry communication problems, and if it is fully appreciated that the more portable and less powerful transmitters cannot be expected to substitute for the more capable fixed stations of greater power, any operating agency should be able to adapt its equipment to the particular problem or condition to be encountered. In inaccessible areas where portability is at a premium, low powered sets of little weight should be used with the intention of communicating short distances only, or of seeking an ideal communication site at high elevation from which the low powered set could reach a somewhat distant station. In slightly more accessible areas where some few roads radiate, the strictly portable sets could be supplemented by automobile stations which could pick up messages from the low powered transmitters and relay the information to and from a more distant fixed station. In most cases where the highly portable set lacks sufficient power to contact distant fixed stations, it should be possible to pick up its messages through special mobile stations sent to a selected location for that purpose, or in some instances by established receiver-pickup stations connected to a fixed station by permanent telephone line. An important thing to remember in any use of the ultra high frequencies is that they have definite communication limitations, and, if the use of the equipment is properly planned to come within those limitations, communication can be successful.

Reduced Electrical and Remote Station Interference

The type of receiver that has been most widely used in ultra high frequency reception is known as the super-regenerative receiver which presents several distinct advantages, as well as some few disadvantages. In the operation of such a receiver, at all times when a signal is not being received, there is a constant roar or sound similar to the rushing of a current of air, but this rushing noise is instantly obliterated as soon as a signal of satisfactory strength is received, and messages by voice come clearly from the loud speaker or from the headphones the same as would be the case in any other type of receiver. In the case of a weak signal, the voice may still sound clear and distinct, but the rushing noise may be heard as a subdued sound below the sound level of the signal.

New operators may complain that the constant roar of the receiver is annoying to them, but experience indicates that an operator gradually becomes accustomed to this sound with the result that it soon ceases to be a source of annoyance, and also he learns to turn down his receiver volume so as to keep the sound at a low level except when there is some reason to increase the volume in order to pick up a weak signal. Although this characteristic is something of a disadvantage, there is a compensating advantage in that these receivers are nearly immune to static noises such as electric motors, automobile ignition, electrical storms and various man-made electrical disturbances. They may be operated during thunderstorms or close to heavy automobile traffic with practically no interference from static. There is a further advantage in receiving signals from unstable stations in that such receivers pick up signals quite broadly and, therefore, will receive a station without resetting the tuning dial even though the station has drifted to the limit of frequency tolerance. Super-regenerative receivers are usually composed of but two to four tubes with comparatively simple problems in construction and servicing.

In spite of the foregoing advantages, the more complex and expensive superheterodyne receiver is gaining favor along with the advent of more stable transmitters. However, although the superheterodyne is much more sensitive to weak signals and is more selective in tuning stations, it picks up static of all kinds and especially automobile ignition noises and in its present development is extremely difficult to use on or near main highways where much traffic is encountered. Construction and servicing problems are much more complex in this receiver, and although several new models have been produced equipped with noise silencing circuits to cope with static interference, they are still in a developmental stage and are not very effective. Therefore, the characteristics of the super-regenerative receiver should be listed as one of the important advantges of ultra high frequency communication.

Another important advantage in the use of ultra high frequency radio in an extensive communication system is that stations operated not far distant from each other on the same frequency, but beyond the horizon, do not cause interference with each other. It has previously been pointed out that any two stations desiring to communicate must be within the horizon of their antennae, and therefore stations beyond the horizon from each other cannot hear each other's signals. The fact that all or portions of one protection district would undoubtedly be within the horizon distances of radio stations in adjacent protection districts makes it desirable that unrelated stations in adjacent districts be operated on separate radio frequencies.

However, in protection districts which are not adjacent to each other, it is un-

likely that any portion of one district will be within the horizon of radio stations within the other district. For that reason, the stations in districts that are not immediately adjacent to each other could be operated on the identical radio frequency without causing interference between districts. This means that the use of a designated frequency by the stations of one district network can be repeated over and over again by distant networks beyond the horizon without danger of interference as long as different frequencies are used in any districts bordering on each other. This accomplishes a wonderful economy in the use of radio frequencies as the available frequencies would quickly be obligated if they could not be used repeatedly at some distance apart. Thus, although Maryland has nine forest protection districts, it is believed from preliminary tests that it will be possible to use only four frequencies in setting up nine non-interfering networks. This characteristic is of the greatest importance in enabling an extensive use of the ultra high frequencies by many agencies.

Many agencies have hesitated to venture into the radio field due to the exorbitant prices that have existed for long wave equipment and the difficulty in locating sufficiently tested ultra high frequency equipment. Only during the past year or two have many of the special parts, needed for ultra high frequency construction and repair, become available. Manufacturers have only recently perfected some of these specialized parts with the result that active competition in this field has not yet developed, and the higher costs for engineering and design are still being collected as a part of the cost of production. However, a few dependable manufacturers outside of the commercial experimental group have begun to sell standardized models on a production basis at prices that are not at all prohibitive.

Small low powered portable transceivers, suitable for cross country packing and communication on the fire line, are selling for from $20 to $40 each complete with batteries, tubes, and necessary accessories.

Six to ten watt transmitters with companion receivers suitable for automobile operation, complete but without battery, sell at $200 to $300 per set, without crystal control. Other automobile installations with crystal control and signal strength as high as 15 watts cost $500 to $600. Simple receivers only, with speaker suitable for automobile use, cost $30 to $40 each, while the more sensitive superheterodyne receivers, which are just being perfected for automobile use on the ultra high frequencies, will probably cost around $100 to $150.

High powered transmitters suitable for lookout tower or central station operation can be obtained for prices ranging from $200 or $300 to several thousand dollars depending upon the refinements and capabilities incorporated in the equipment. Simple oscillator 15 to 20 watt transmitters, without crystal control, suitable for operation on 110 volt A.C. current, can be purchased for $200 to $300, but if greater power, crystal control, sensitive microphone or other refinements are desired, the cost is higher. Extremely sensitive superheterodyne receivers, suitable for fixed station operation, are now available at about $100 each.

The trend will undoubtedly be towards less expensive equipment, although for short periods there may be slight upward tendencies as new improvements are perfected, and stricter federal regulation forces the use of more stable equipment. Many of the newer parts, such as metal and acorn tubes, have been made available through years of expensive research and the design of costly machinery. Easier and cheaper methods of production are certain to be developed and increased demand in itself will bring about economies through quantity production methods. Short cuts in assembly and opportunities

for consolidating parts will be discovered enabling simplified production technique. Not the least of the economies that can be confidently expected is the development of standardized plans for small shop production of receiver, power supply, radio frequency, and voice modulation units which can be assembled from standard parts by artisans with little actual radio knowledge.

There is a tendency among radio technicians to surround their vocational efforts with an atmosphere of uncertainty and mystery which is hardly justified with regard to station operation as distinguished from pure research. An experimental radio service while involving operational studies, need involve but little basic research into the theory and fundamentals of radio behavior which is more strictly the field for the scientifically trained radio engineer. As the methods for assembling ultra high frequency radio parts gradually become standardized, we can expect technicians to show a greater certainty in procedure, and much of the present mystery will give way to an understanding and instructional attitude which will be most helpful in directing mechanically minded employees in an economical assembly of ultra high frequency radio equipment that may be used by them.

On first consideration, agencies contemplating the purchase of radio equipment may feel that custom built units should be superior to home-made outfits, but for a number of reasons the composite assembly made by regular personnel should be given careful study. Although custom built equipment is usually well designed and attractively finished, it frequently contains inferior parts that easily and quickly rust or corrode, and that may not be adequate to stand up under the heavy electrical currents that they must carry. Further than this, the workmanship in quantity production is frequently inferior due to unsatisactory soldering of connections and insufficient attention to minor details which may later cause trouble.

Needless to say, the cost of labor in constructing factory made sets must be charged to the cost of production, which may not be necessary in small shop construction as time of employees primarily engaged in fire fighting or other activities can frequently be contributed for short periods or after usual working hours in the construction of radio equipment. And, finally, the advantages of having certain personnel become thoroughly acquainted with the essential structure and arrangement of parts in the various radio units is of great importance in developing employees who can quickly repair ailing sets in the field, as well as qualify for advanced licenses enabling approved supervision of station operation in new ultra high frequency communication areas.

While experience indicates that it is a mistake to permit employees to dismantle equipment that is functioning satisfactorily, it has proven to be good policy to encourage them, under proper supervision, to assemble homemade outfits which become the property of the employing agency. Two transmitters produced in this manner have proven satisfactory for forestry communication in Maryland and a third now being developed holds promise of interesting improvements. Undoubtedly, with the development of greater knowledge and ability in the assembly of standardized equipment, this method of producing needed radio sets will be of increased importance.

Specialized Equipment and Fields to Which Adapted

Forestry and conservation work presents so many distinctive communication needs that there is a considerable variety of specialized equipment adapted to the particular operation conditions to be encountered, and as new designs and technique are perfected, an even larger variety of equipment can be expected. One of

the most unique and flexible units is the transceiver which is of comparatively simple design and usually has but two tubes. It is highly portable being operated from dry cells and in the best models can easily be carried on foot to points far from roads. Such equipment usually weights about 25 pounds and, where optical-line-of-sight communication is possible, can cover distances as great as 50 miles. However, its signal power is too weak to communicate more than three or four miles with other stations on the ground or shielded by timber. The same tubes that are used to transmit a message are used in a different wiring arrangement to receive a message by simply turning a switch, but an inherent difficulty in this type of operation is that in receiving in this manner a unit of this kind creates great interference over a small range, which would prevent another receiver or transceiver, operated nearby, from clearly hearing an incoming message. Further than this, a transceiver can never transmit and receive messages simultaneously, as it functions either as a transmitter or as a receiver, but not both at once. This means that two communicating units cannot interrupt each other's messages, but must wait for the one transmitting to complete its message before the other transmits.

Transceivers are extremely non-selective, both in transmitting and in receiving, putting out a signal several hundred kilocycles broad, and receiving signals over a similar frequency band. While this makes it easy to tune in any signal that may be on the air, it may be difficult to tune out an interfering signal by some adjacent service, and in turn the transceiver signal may cause interference to adjacent services. Unfortunately, the construction of transceivers is such that control of frequency stability or reduction of side band interference is not practicable. It has not been announced whether the use of transceivers will be terminated by the Federal Communications Commission upon the effective date of the new frequency allocations, but unless some special frequency tolerance exemptions are defined for low powered equipment, it appears possible that the use of transceivers, by other than amateurs and government agencies, may be prohibited. This would be unfortunate as there is nothing that can equal them for short range communication on the fire line and between locations that are difficult of access.

Another very flexible type of equipment is the so-called trans-receiver which has greater capabilities than the transceiver, but it is considerably less portable although still within the class of portable equipment. Instead of using all tubes in both the sending and receiving circuits, there are one or two tubes that function exclusively in producing radio energy for transmitting, and a third tube that functions exclusively as a detector in the receiving circuit, while three other tubes function either in sending or in receiving as a part of the audio or sound amplifying circuit.

This mechanism is necessarily larger than a transceiver as it possesses two to three times as many tubes as in a transceiver, all but one of which must be operated when transmitting. The operation of these additional tubes necessarily requires a stronger power supply than can be obtained through direct battery connection, and, therefore, a small battery-operated dynamotor produces the needed higher voltage. Such batteries are necessarily larger, heavier and more costly than those suitable for transceivers and they are the main factor, coupled with the dynamotor, in decreasing portability. In extended operation, the dynamotor exhauts the batteries rapidly, making frequent replacement necessary. However, if portability is not an objective, the heavy wet cell batteries, which can be recharged, are more economical.

The main advantage of the trans-receiver

over the transceiver is that it has greater power, taking up where the transceiver quits at about three watts, and extending upward in signal strength to about 8 or 9 watts, portability decreasing as power is increased. This increased signal strength enables communication over a greater range than the transceiver, and such equipment is suitable for operation under very exacting field conditions. It is ideal for remote camps which may serve as temporary headquarters for emergency operations to which equipment may be packed by man or horse. It is similar to the transceiver in being able to receive only, or to transmit only, at one time, but it differs in being more selective and capable of more exact frequency control with less possibility of objectionable interference.

In the semi-portable class should be mentioned the independent transmitter and receiver combination assembled in one unit. Such equipment is capable of the very best frequency regulation with signal strength up to 10 or 12 watts, enabling communication under ideal conditions up to 100 miles and considerable lattiude in overcoming signal absorption within 6 to 8 miles. However, such equipment is battery and dynamotor operated and weighs from 50 to 100 pounds or more, which makes adequate transportation facilities necessary in obtaining portability. It is suitable for rather extended operation, though temporary, providing occasional battery replacements are arranged.

Mobile radio equipment is especially designed for automobile operation, both stationary and while in motion. It is in this field that ultra high frequency equipment has an exclusive advantage that has never been available to the lower frequencies; namely, the ability to transmit messages from a rapidly moving vehicle. Obviously, the very long antenna system of the lower frequencies made transmission of messages from a moving automobile an impossibility. Many interesting refinements have been perfected for this class of equipment, making easier the remote operation of equipment from the driver's seat, with special tone signals to warn pick-up stations to listen for an ensuing message, and novel antenna attachments preventing damage in striking low hanging trees or other stationary objects. Transceivers, trans-receivers and independent transmitter-receiver units have been used in mobile operation but since portability is not an objective, the trend is towards the more capable transmitter-receiver combinations. The best of such equipment is highly selective and capable of the best frequency control.

Most equipment is automobile battery and dynamotor operated and is, therefore, limited to 10 or 12 watts signal strength, but through the development of other means of electric power generation, as by means of engine driven generator, more powerful equipment will probably be developed. The mobile radio station places the field worker or smokechaser in constant touch with fixed stations, enabling constant two-way operation while in motion, so that he can be contacted or he can call for information the instant it is needed. This is of the greatest importance in a rapidly functioning emergency service.

Radio equipment adapted to forest fire lookout towers should be of specialized design as such stations are ideally located and are, therefore, capable of the very best results in high frequency communication. By capitalizing on this advantage through use of powerful transmitters and sensitive receivers, it is possible to overcome many of the disadvantages of low power and unsatisfactory location of other stations. In addition to being equipped with transmitter-receiver sets of the very best design, such equipment should be housed in special cabinets so planned as to fit compactly into the minimum space without depriving the towerman of needed room for his usual activities. When high powered

transmitters are too bulky to be placed on one or more shelves of the towerman's range finder table, the transmitter can be remotely placed in a special compartment above or below the tower cab with remote controls mounted in a panel on the table. Since the towerman must work at his table in sighting smokes, studying his map, and use of telephone, it is quite important that his radio controls and microphone be placed conveniently for efficient use.

Although, only one of Maryland's lookout tower transmitters has had a signal power in excess of 20 watts, it is believed that a minimum power of 20 to 30 watts is desirable in obtaining adequate coverage; and under difficult operating conditions, power as high as 50 watts may be desirable. This means that 110 volt A.C. power supply is necessary at such stations and where commercial current is not available, thoroughly dependable gasoline engine generators can be installed for about $300. Of course, lower powered battery operated stations can be used at lookout towers but they do not enable the best communication results to the full extent of a station's horizon. Although superregenerative receivers have proven satisfactory at lookout towers, it is anticipated that superheterodyne receivers may become popular at such stations due to their extreme sensitivity in picking up weak signals from shielded ground stations.

However, in housing powerful and valuable radio equipment in lookout towers, it is important that the tower quarters be secure against trespassers, as well as capable of excluding wind driven rain and snow. This calls for better design and more thorough workmanship in finishing such structures than has been common in many sections of the country.

Because of the very advantageous location of stations at lookout towers, it is anticipated that multiple receiver and transmitter equipment with both automatic and manual controls may be desirable at centrally located towers which may serve as relay stations for an encircling group of towers. Signals thus picked up on one frequency by a receiver, and automatically rebroadcast by a transmitter on another frequency, could in this manner be relayed by way of a central tower to a distant headquarters. Further, a whole series of relay stations might be operated through selected towers, enabling contact between remote portable or mobile stations and district or state headquarters.

Of course, there is a limit to the number of times that a signal can be relayed, for each time that a receiver picks up the signal there is a certain amount of distortion, which accumulates with each additional relay. However, as distortion is reduced through improved equipment, an increase in relaying ability can be expected. Preliminary tests in Maryland clearly indicate that these chains of automatically operated relay stations are a distinct possibility which will be perfected as equipment and technique develop.

The central control station for each communication network must necessarily be equipped fully to control and intelligently direct the radio performance at each station in its network. This control station must have a transmitter with sufficient power either to reach the most remote stations in the network or to contact them through relay. Such stations should probably have a signal power of not less than 50 watts and possibly as high as 100 watts. This high power is of value to the control station in contacting distant headquarters in adjacent districts and in communicating with portable and mobile stations at times when lookout towers may be inoperative. In some instances, the control station may be at one of the lookout towers, or the central headquarters may be close enough to a lookout tower so that radio equipment at the tower can be operated from the headquarters by remote control line. Such

a control line is now scheduled for erection at one of the Maryland district headquarters.

However, if it happens that the control station is so located that a lookout tower cannot be utilized for mounting the antenna of the control station, it is desirable that a high radio mast be provided at the control station. This will add to the effectiveness of the station in much the same manner that the higher transmitting power is helpful, enabling greater communication ability with distant and shielded ground stations. A 160-foot, three-legged, timber tower put together with split ring and alligator connectors, with a 20-foot central mast, is now under construction at one of Maryland's district headquarters. Towers of less than this height would be adequate if they could be located on a slight elevation.

In order to maintain the stations in service and to check their frequency according to federal requirement, a number of pieces of auxiliary equipment are necessary at the control station. For ordinary station servicing and in construction work, the technician will need a supply of pliers, screw drivers, soldering irons, drills, cutters and other small tools which should be assembled in small cases suitable for transportation to distant stations. Also, in order to locate sources of trouble, some sort of metering equipment, which will read several values of voltage, current, and electrical resistance, is desirable. A portable electrical analyzer, similar to the type used by home radio servicing agencies, is quite suitable and will cost approximately $20.

To check radio frequency more precise equipment is required. For determining quickly the frequency of new transmitters or receivers when first installed or after an overhauling, a simple direct-reading tuned-circuit wavemeter costing approximately $40 should be obtained. This instrument will save much time and exasperating trouble in determining the approximate frequency of a signal prior to making a precision adjustment to the exact frequency desired. However, for the final precision adjustment, a heterodyne frequency meter-monitor, with micrometer adjustment and lens reading dial, costing approximately $100, is necessary, which enables a positive frequency check as required by the Federal Communications Commission.

All of these instruments should be mounted in cases suitable for field use and transportation. A supply of replacement tubes, batteries, transformers, and resistors should be carried in stock at the control station and if breakdown of stations is likely seriously to handicap the service, as is the case in forest protection work, an emergency radio repair vehicle should be constantly available at the control station. This vehicle, if fitted with compartments for the various tools, parts and instruments, becomes a very vital part of the radio servicing equipment, and if fitted with siren and other emergency vehicle attachments can overcome many traffic obstructions in placing an incapactiated station back on the air with the minimum delay.

It may not always be possible for a control station to contact a headquarters in an adjoining protection district with the same equipment used for communication within its own network. Therefore, in contacting such stations, it probably will be necessary for control stations to be equipped with multiple transmitters and receivers similar to those described for relaying at centrally located towers. A special frequency for interdistrict communication should probably be set aside, the use of which would not interfere with communication within either district, and, of course, addtional transmitters and receivers operating on this selected frequency would be necessary at the control station in each district. Frequently it may be possible, due to satisfactory elevation, for a control station to serve both

as a central relaying station and a district control station. This will result in a considerable concentration of multiple equipment at the control station.

However, this amassing of equipment, instruments and radio facilities at the control station does not necessarily mean a large annual expenditure for radio supervision. True enough, certain capital investments are required in building up the facilities for radio communication including central control for each network, but a very satisfactory economy in administration is possible by using the supervising radio operator as radio technician and fire dispatcher. Thus, he not only listens to all radio messages and can check their frequency as needed, but he can obtain the azimuth degree readings on all smokes and can plot their locations on the triangulation map at his station. He dispatches the various smoke investigators and fire fighting crews by radio or telephone call, and because of his intimate knowledge of the location of various personnel and equipment, he is able to direct the placement of portable and mobile radio stations to best advantage. In exceptionally busy districts, an assistant dispatcher may be necessary in peak periods to handle telephone calls under direction of the chief operator. In case of breakdown, a field worker or local official may be called in to handle the dispatching temporarily while the technician goes to the incapacitated station to make repairs. This is the system that has been used in Maryland with an encouraging improvement in the instruction and dispatch of investigators and fire fighting crews.

The Improvement and Perfection of Equipment

Throughout this article a great deal has been written concerning numerous improvements in equipment and technique which have occurred during the last few years or are confidently expected. It appears certain that the ultimate in development of radio facilities has not yet been reached. At the start of forestry radio developments in Maryland, our transmitters were all of the modulated oscillator type. In this type of transmitter only one tube circuit is used to perform the three functions of generating the radio frequency energy, controlling the length of the frequency, and having the voice modulation impressed upon it. This arrangement, while giving satisfactory results, does not provide good frequency stability because of the wide variations in current impressed on the controlling constants, and in such transmitters, no other arrangement for obtaining positive frequency control is included. As a result, a signal fluctuation over a wide frequency range may occur due to slight variation in the tuning condensers resulting from a jar to the apparatus, or by other conditions that cause current fluctuation.

A number of improvements have been developed that bear promise of better frequency control without the necessity of restricting a transmitter to a selected frequency. These improvements have been the result of an endeavor to attain an adjustable control of frequency which would enable shifting a transmitter to new frequencies, without great difficulty or expense, should such change be required through a new allocation of frequencies.

In one type of frequency control the transmitter is known as the long-line oscillator type which has been used with great success in some services, particularly in New Jersey. In this arrangement, the frequency is controlled by parallel rods of adjustable length, the control being accomplished through the physical length of the rods which is held constant by means of thermostatically-operated electrical heating units. While offering a very high degree of stability, this innovation presents the disadvantage of great bulk as the long lines are 6 to 7

feet long and they carry a high potential which may cause a very painful shock.

Another type of frequency control has been offered through the master oscillator power amplifier circuit, commonly referred to as MOPA, which is generally considered the most satisfactory adjustable frequency control yet developed. In this arrangement, one tube serves exclusively to generate the radio energy, while one or more additional tubes act as amplifiers, are modulated by the voice, and transfer energy to the radiating system. Although this system of frequency control has the advantage of adjustability, the degree of stability is not all that is to be desired, even though it is a great improvement over the simple modulated oscillator transmitter.

The so-called crystal control of transmitter stability is now considered the ultimate in frequency regulation although such regulation is fixed without possible adjustment to other frequencies except at considerable expense. This factor, coupled with the temporary allocation of frequencies to various services, has discouraged a more prompt adoption of crystal control. In crystal control a small plate of Brazilian quartz ground to a definite thickness is placed in the radio circuit, which thickness determines the only frequency that can generate from the quartz due to its special electrical characteristics. Such crystals must be ground with great care to avoid breaking, are not adaptable to any other frequency, and cost about $30 to $40 each.

This method of control is used exclusively by commercial radio stations and to great extent by special services where a permanent frequency has been allocated. The stability obtained is of the order of one part in a million. The investment in this type of control can only be justified where there exists some assurance of permanent frequency allocation.

Improvements in antenna systems may prove to be a potent field for increased communication efficiency, particularly in the development of directional systems for concentrating a signal upon an area where it is to be received. While it is true that most radio stations of a forest protection agency need to send their signals in all directions in order to contact a number of portable and mobile stations at indefinite locations, the use of directivity may be helpful in sending a signal into poor receiving areas or to a single remote station. Much is yet to be learned with regard to signal strength from various types of antennae, as well as the position of the receiving antenna in relation to the transmitting antenna. Also, there are some possibilities in development of multiple and reflective antenna equipment.

However, these fields are so new and so little research of this kind has been reported, that it is difficult to imagine the nature of improvements yet to be made. It is even possible that antenna with adjustments enabling vertical and horizontal rotation, so as to direct the maximum signal strength into a given area, may be developed in recognition of the fact that the field strength pattern of any antenna indicates a stronger signal at certain angles from it than at others. Precision adjustments with regard to antenna arrangements, although recognized as important, are not generally understood and applied so as to obtain the best results. Therefore, the technique of installing and testing antenna fittings can probably be improved upon as much as the antenna equipment itself.

Probably one of the greatest improvements in the efficiency of ultra high frequency radio equipment can be effected through the discovery of more satisfactory conductors and insulators for high frequency radio energy. It is well recognized that materials, such as rubber, which serve as efficient insulators for electric current and low frequency radio energy, are actually fairly good conduc-

tors for high frequency radio energy. This causes high losses in radio energy in conveying it from one part of the apparatus to another and in particular over the feed line from the transmitter to the antenna. For this reason, ultra high frequency transmitters are usually designed so as to have as short connecting conductors between various parts as possible and transmitters are located close to the antenna so as to have as short a feed line as possible.

Higher grade ceramic materials such as isolantite are among the best known insulators for ultra high frequency energy, but even they permit an objectionable loss of energy. The concentric feeder line, mentioned earlier in this article, is one of the best conductors so far developed, and employs a minimum number of porcelain discs within a metallic tubing, through the center of which a solid conductor carries the energy. Concentric cable is closely related to the coaxial cable recently perfected in the development of television, employing the best known conductors along with the best known insulators to produce a simple and acceptable means for conveying ultra high frequency energy. However, still greater improvement is needed along this line as the losses are much greater than in the operation of long wave equipment.

Any discussion of contemplated improvements in the use of ultra high frequency equipment would not be complete without reference to possibilities for combining radio and telephone facilties, as well as for attaining automatic operation and remote control of certain equipment. Although commercial telephone companies have not yet provided the means for connecting a radio receiver to commercial telephone circuits or of connecting such circuits to the microphone of a radio transmitter. these are definitely possible of accomplishment. There is no reason, electrically speaking, why a message from a mobile transmitter could not be picked up by a strategically placed receiver, as at a lookout tower, and the electric impulses from the audio circuit transferred directly to the commercial telephone line and thence through its switchboards to distant telephone instruments. Similarly, it should be perfectly possible to take the electrical voice impulses from a commercial telephone circuit, with amplification if necessary, and apply them to the audio circuit of a radio transmitter, thus broadcasting the telephone message to any number of radio receiving sets.

The perfection of equipment and technique for this type of service can be of great value in connecting portable and mobile radio stations to highly developed forest administration telephone lines; for every telephone instrument will thus become the means for receiving radio messages from remote forested areas, and in turn the telephone system will be able to extend its communication range beyond its land wires through the ether into areas where telephone lines can never be justified. Even now in certain radio services, receivers and transmitters are operated from a great distance by remote control lines which in all essential respects are similar to telephone circuits and in fact many such remote control lines are erected and maintained for the broadcasters by the telephone companies. The only differences between ordinary telephone circuits and those used on remote control lines are the differences in voltage, amperage and frequency which are electrical qualities to which equipment can be adapted.

The automatic electric relay switch, commonly referred to as an automatic relay, has great potential possibilities for the perfection and special adaptation of equipment. Through the use of this mechanism, automatic volume control has been added to one of the Maryland superregenerative receivers, enabling an elimination of the hissing or rushing sound that is usually heard when this type of receiver is turned on with no signal on

the air. Under this arrangement the volume control gain is turned down so low that there is no sound from the receiver, but as soon as an incoming signal activates the relay the gain turns up automatically, making the signal audible, and as soon as the message is completed the volume is automatically reduced until another signal is received. Some difficulty has been experienced in adjusting the relay to respond properly to signals of various strength, but it is believed that this difficulty can be overcome.

Similar relays are used to manipulate the switches of a station by means of remote control and in many operations where it is desired to turn a number of controls in a single operation, as for example, pushing the microphone button to talk, which automatically turns off the receiver, and turns on the transmitter, as well as connects the circuit to the microphone. In any attempt to solve difficult radio engineering problems, uses of the automatic relay should be given prominent consideration.

The use of remote control systems as a means for overcoming radio communication problems in the ultra high frequency field should not be overlooked. It is perfectly possible, with the most scientifically designed equipment and carefully located stations, to be unable to pick up messages from portable or mobile stations in areas that are severely shielded by intervening mountains. Such a condition could be corrected through establishment of an unattended radio receiver within the shielded area, connected by remote control line to the station that is shielded from the area. This remote receiver could be put in operation from the station operating the control line whenever it is known that messages are likely to be received from the shielded area, thus making it unnecessary that the remote receiver operate constantly. Further than this, complete transmitting and receiving stations could be operated in a similar manner by remote control, with the control switches, microphone and loudspeaker distantly located from the station.

Where forest administration telephone lines are already established, the erection of remote control lines on existing telephone poles is a relatively simple development, the main expense being for the control cable and the remote stations. There is a further possibility of operating unattended radio relay stations by means of a constantly operating receiver connected by an automatic electric relay to the transmitter.

Thus, it is conceivable that a remote unattended automatic radio relay station without any kind of control line could be established as follows: first, a wet cell battery kept constantly charged by means of windmill or waterpower generator could operate a receiver which would be in constant operation; second, this receiver would be connected by means of automatic electric relay switch in such a manner that an incoming signal on the receiver would activate the relay switch thereby turning on an automatic starting gasoline engine generator; and third, the starting of the gasoline engine generator would place the transmitter in operation, rebroadcasting on a different frequency the message picked up on another frequency by the receiver. Such a station could operate indefinitely except for occasional visits by an operator to put water in the battery, supply gasoline for the generator and give general servicing and replacement attention to the apparatus. It is confidently believed that such developments will become an actuality within a few years in many sections of the country.

Summary and Conclusion

Although the advantages from the present use of ultra high frequency radio are very great, there are still many developments to be made before it can be used universally in forestry work. However, those public agencies interested in gaining

the present advantages in the use of radio can do so at moderate expense by following the suggestions expressed in this article. The main points to be considered in making such a development may be summarized as follows:

1. Arrange technical radio supervision by a licensed operator employed either on a part time or full time basis.

2. Ascertain federal regulations and license all stations and certain selected operators who cannot be supervised by the radio technician.

3. Select equipment technically adapted to the performance to be required of it and do not expect specialized equipment to serve all purposes.

4. Recognize rapid changes and improvements that are to develop and enable capable personnel to modernize equipment as rapidly as necessary.

5. Avoid costly equipment which may soon be obsolete, but obtain as high quality and as modern equipment as current progress can provide.

6. Be prepared to recognize opportunities for perfecting needed developments in equipment and technique, and have sufficient vision to realize that relatively simple discoveries may overcome great difficulties in radio communication.

It is our conviction that ultra high frequency radio has now emerged from the strictly experimental stage and is showing a tendency towards standardization as to types of equipment with definite knowledge as to their effective ranges and uses. Unquestionably the many changes that have been taking place have held back adoption of ultra high frequency radio by many agencies that were hesitant to invest in equipment that would apparently be obsolete in a short time and was of doubtful service value during its life. However, recent developments seem to point to a more stabilized position, and with the selective allocation of frequencies to various services by the Communications Commission, with production of simpler and better equipment, a much more definite program may be planned. Therefore, it is hoped that this elementary presentation of fundamental considerations in the use of ultra high frequency radio may point the way for more agencies to make an expanded use of radio, leading to advances in better forest protection and a further development of the radio art.

RADIO IN COUNTY FOREST FIRE CONTROL

By H. J. MALSBERGER[1]
Florida Forest and Park Service

THE Florida Forest and Park Service took the lead in experimenting with short-wave radio communication in the control of forest fires in Florida. A station was erected at the Dinsmore Ranger Station, fourteen miles north of Jacksonville, on State Road 4, Duval County, in November 1936. Duval County was the first county in the state to embark upon a program of county fire control where the county commissioners, rather than individual landowners, cooperate with the Florida Board of Forestry. There are 268,954 acres being protected. The station was also located for the purpose of serving the cooperators in the adjoining county of Nassau, whose lands total about 100,000 acres. It is reasonable to expect that all the forest lands in both Duval and Nassau Counties, totaling nearly 759,000 acres, will be listed for protection in the near future. The area, therefore, is desirable for the initial attempt.

This article has been prepared with the idea of attempting to assist other agencies or individuals who are interested in installing a similar radio communication system.

Kinds of Radio

It is perhaps essential to mention here that the use of the radio falls into two general classifications: (1) broadcast and (2) communications. Broadcast refers to the use of the radio for the entertainment and education of the public; while communications refers to the use of the radio for the distribution and exchange of information. The voice or a code system, somewhat similar to the telegraph codes, is always used in this classification of the radio. The communications division of the use of the radio serves the public in many ways. An outstanding example is its use by the police systems. The use of the radio in forest fire control work falls in the same category by supplying information which benefits the general public. Everybody loses when timber burns and any action which reduces the acreage burned is assisting to conserve a natural resource which is beneficial to all.

Collins Type FXB Transmitter

This station is operating through a permit issued by the Federal Communications Commission under a "special emergency license" classification. The station has been assigned an operating frequency of 2,726 kilocycles with the call letters WANB and has an output of 100 watts.

The transmitter is a Collins type FXB and is manufactured by the Collins Radio Company, of Cedar Rapids, Iowa. It is an amateur set but was converted for commercial use by the addition of protective devices. These automatic, protective devices consist of an overload trip and time-delay relay which prevents damage to the equipment by accidental overloading.

Information is transmitted by using voice modulation only, rather than code, because the personnel are not trained in receiving messages in code. The use of code would allow the installation and operation of smaller equipment and less

[1]Acknowledgment is made here to John P. Bryan, radio operator and chief dispatcher at the Dinsmore Ranger Station, who so splendidly collaborated in the assembling of the information contained in this article.

power would be required to reach the same distance.

The feature of the station is the frequency control, made possible by a special crystal ground to exact frequency, which is installed in an oven which automatically maintains a constant temperature of 53° C. The assigned frequency of the station is checked twice a month by the Radio Corporation of America's laboratory, located at Riverhead, Long Island. The operator has been exceptionally successful in staying within a very slight variable of the allowable frequency tolerance specified by the Federal Communications Commission.

The approximate cost of the transmitter which is now being used by the Florida Forest and Park Service is $800.

Control Points

The station has two control points, one located in the county ranger's office and a remote control point in the lookout tower. This arrangement makes it possible, under ordinary fire conditions, for the radio operator to be the lookout and dispatcher at the same time. During the peak of the season, however, two men are required. The advantage of having a remote control point in the observation tower is that the radio operator can keep in closer touch with the condition of going fires, and is thus enabled to keep better control of the crews.

The remote control point must be equipped with a modulation monitor in order to determine that the station is operating correctly when the operator is removed from the transmitter. It must also be equipped with a receiver and a switch to turn the transmitter off and on. The cost of this additional equipment amounts to $150 but is well worth the investment because it provides a more flexible system of broadcasting.

Station Receiver

The receiver in the station is designated as the "station receiver" to differentiate it from the receivers in the trucks. It is a RME 69 model, manufactured by the Radio Manufacturers' Engineers located at Peoria, Illinois. It is a communication, band-switching, superheterodyne type of receiver, covering a frequency range of 550 to 32,000 kilocycles. The band-switching and large-range features are the important factors of this receiver as contrasted to other types which have a limited field. The wide-frequency range is not absolutely essential but is desirable in the event the Federal Communications Commission may change the frequency or assign another frequency to the Florida Forest and Park Service to take care of portable mobile equipment used in two-way communication. The present equipment is flexible enough to take care of such a possible situation.

The cost of this equipment is $150.

Antenna and Ground

The antenna and ground can properly be considered to be the most important single item of the station. The dependability of reception over the area is governed by this equipment. The objective in the construction of a forest fire control radio station is to concentrate power, which is equally radiated in all directions around the transmitter, along the surface of the earth. If the antenna is located near the center of the protected area it must be absolutely non-directional in order to assure proper reception in areas of the control unit. The concentration of power along the surface of the earth is also essential to secure consistent reception of messages five miles distant from the transmitter as well as thirty-five miles or more. Station WANB was constructed for the purpose of obtaining a forty-mile radius. Consistent coverage has been checked and found that reception is satisfactory within a radius of thirty miles. No tests have been made beyond this point but indications are that the reception will

be satisfactory within forty miles.

The strong ground wave is accomplished by the use of a quarter-wave Marconi antenna suspended vertically from a ninety-five foot pole. A number ten copper wire is used on the pole for the antenna. The Department of Commerce requires poles erected within ten miles of an airport or airway to be painted. It is, therefore, essential that the pole be not creosoted but be treated with some other preservative.

At a point in the ground, exactly beneath the center of the transmitter, a 12-foot by 16-foot copper-mesh screen is buried eight inches deep. A twenty-foot section of 1½-inch galvanized iron pipe establishes a permanent ground to which is attached the screen. Sections of number twelve copper wire are soldered to the screen and extend radially from it. The eighty-four radials are eighty-seven and a half feet long and the wire is buried six inches in the ground and terminates in a 6-foot galvanized ground rod. The wires were easily placed in the ground, without disturbing much sod, by the use of a dibble.

The complete cost of the antenna and ground is about $300.

Incidentally, part of the power reaches the sky wave and is used for contacting monitor stations at distant points for frequency tests. Cards verifying reception have been received from short-wave enthusiasts as far north as the New England and Great Lake states. This same power could be used for communicating with forest fire control stations at distant points to check on approaching weather conditions and for exchange of other valuable information.

Microphones

Crystal microphones are used at both transmission points, thus eliminating batteries which would be necessary if carbon microphones were used. They are Shure type 70 S made by the Shure Brothers Company, Chicago, Illnois. These instruments are made especially for voice frequencies. They cost $15 each and two are in use, one in the station and the other in the tower at the remote control point.

Control Panel

The control panel and table were made by the operator and are constructed of tempered Masonite to which was applied a coat of lamp black. The unit is entirely satisfactory and cheap, costing $25 complete. It employs a fool-proof switching device arranged so that the two control points could not possibly interfere and have two people talking at the same time. This is a very necessary safeguard due to having a remote control station in the cabin of the tower. It is necessary to keep an accurate electrically-operated clock to regulate the proper times to go on the air.

Receivers in Trucks

Philco types 810 PV and 811 PV (police variable) receivers are used in the trucks of the Florida Forest and Park Service and C.C.C. organizations. This equipment has a tuning dial instead of a fixed frequency which makes it more valuable because it can receive messages broadcast from stations having different frequencies than that assigned to this station. It means further that the equipment need not be altered if this station's frequency is changed. The receiver is widely used in police radio systems and costs $35.

A feature of this equipment is the loop-receiving antenna attached to the top of the cabs on the trucks. The antenna mounting is constructed of oak on a metal frame. Number twelve copper wire is threaded inside the mounting on bakelite insulators. This antenna is cut to approximately a quarter-wave, ninety-two feet of wire being used in this case. The efficiency of such a loop-type antenna is largely responsible for the very successful

and strong reception received in the field. It is impossible to stress too greatly the necessity for sturdy construction of a mobile antenna on account of the hard usage given it by trucks traveling through the woods over woods trails. It would seriously affect the suppression work to be constantly repairing the equipment during the peak of a fire season.

The loop-type antennas cost $22 each, but they can be constructed for $10 each when using your own labor.

Operation of the Station

The radio operator commences testing at nine a.m. and tests each hour thereafter until six p.m., unless weather conditions demand a longer service. If the fire hazard is great, tests are broadcast each half hour. A fire call is broadcast at any time a fire occurs. The receivers in the truck are kept on constantly, if there is any fire hazard, to receive the calls. Specific locations of all fires are broadcast and the county ranger is kept informed of conditions over the unit at all times.

Service Parts

It is very important to the successful operation of a radio station to keep an ample supply of service parts for emergency use. This station carries service parts and test equipment valued at approximately $150.

Operating and Replacement Costs

Cost of power for the transmitter, averaged over a five months' period, amounts to $6 per month. This includes battery charging for Florida Forest and Park Service and C.C.C. radio-equipped trucks and is based on a cost of 3½¢ per kwh for current.

Frequency monitoring service required by the Federal Communications Commission costs $5 per month. The cost of tube replacement and maintenance of the transmitter and station equipment is estimated at $50 per year.

Maintenance of truck receivers is estimated at $5 each per year, totaling $75 for the fifteen receivers operating in the Duval-Nassau unit.

The life of the antenna and ground system is estimated at twenty years, making a cost of $15 a year for replacement. Summarizing, the total estimated cost of operation and maintenance, excluding salaries, for the radio system amounts to $272 per year.

Organization

One man is employed as radio operator and chief dispatcher who has a second-class radio operator's license. He is assisted by an assistant operator and dispatcher who has a third-class operator's license. The duties of these men have been mentioned and in addition it is their responsibility to maintain all radio equipment and receivers and repair telephones.

Conclusion

In summarizing the radio equipment, it is the opinion that the most important factors guaranteeing the successful operation of the station are good antenna and ground for the transmitter and antenna for the truck receiver. These factors make it possible for a transmitter of 100-watt capacity to do a satisfactory job which otherwise might require a 500-watt transmitter. The latter equipment is much more expensive. The total cost of the complete radio installation amounts to $2,610.

The station is now completing six months of service through a partial fire season. It is too early to draw definite conclusions on the exact value of radio communications used in conjunction with a tower and telephone system in the suppression of forest fires. Several outstanding values of the radio are listed. It materially increases the speed in dispatching fire crews because they can start before the triangulation of the fire is completed and be informed en route of the

actual location. One towerman can locate the fire accurately enough to start the crew in the right general direction. It permits the organization to be very mobile which is of primary value. Crews can be patrolling the woods during hazy weather of low visibility or patrolling to prevent timber theft. The crews are not required to remain stationed at a tower or telephone. This permits labor crews to work on forestry improvement projects, such as thinning, planting, et cetera, and still be immediately available for fire suppression work. A man remains in the truck to receive the fire messages in such instances and then collects the laborers.

The use of the radio also materially reduces the mileage and consequently the wear and tear on the trucks. Quite frequently trucks are dispatched to fires en route to the tower or reporting telephone before the complete trip is made. The radio station is located at the central dispatching station which permits the operator to know where the crews are at all times.

As mentioned before, it is not possible to ascribe definite improvement of results at this time entirely to the installation of the radio system. It is apparent, however, that the crews and the entire organization rely to a great extent upon the system. A statement was made that if they had their choice between a tower and telephone system and ten fire trucks with no radio, and a tower and telephone system and five trucks and the radio they would take the latter. The radio system alone does not cost quite as much as five trucks, and when salaries, operation, and replacement costs of the trucks are considered, the comparison is greatly in favor of the radio even from a strictly financial standpoint. In addition, the psychological effect of radio on the public is undoubtedly a distinct asset in forest fire control work, especially during the early stages of such a program.

RADIO COMMUNICATION ADAPTED TO FIRE PROTECTION ON PRIVATE LANDS

By WILLIAM M. OETTMEIER
Superior Pine Products Company

IN contemplating the use of radio in forest fire protection the forester must follow a definite procedure. First, it is absolutely necessary that a station license to operate on a specific frequency be obtained. Second, it is necessary that an operator licensed by the government be in charge of the operation of the station. And third, it is most important that the station at all times be kept within certain allowable limits of its operating frequency.

Prior to 1934 no authorizations had been issued by the federal government for use of radio by private concerns in fire protection. However, that year the Superior Pine Products Company, after a number of refusals, was finally granted a license to operate on 2,726 kilocycles, a special emergency frequency. This action allowed others to obtain licenses simply by making application and having bona fide reasons for its use.

The use of radio is probably one of the greatest steps forward in fire protection. Whether the fire hazard is great or small it allows the men at all times to be at some profitable work in the forest. It is preferable for fire crews to be at work somewhere in the forest rather than concentrated at one or more points waiting for fire calls. If these men are at

work when radio is not used, it is necessary for someone to hunt them when there is a fire call. This delay may cause a loss of time from a few minutes to several hours. On the other hand, when radio is used the various crews can be distributed to advantage and be at work, and still have direct contact with the fire dispatching center and can be sent off without any loss of time.

One Way Communication

The most important condition in the operation of a one way communication system is that the fire dispatcher know at all times where each radio equipped crew is located, the number of men in each crew, and their availability for fire fighting. He must also know that the receivers are kept turned on during the hours specified, and that a crew will immediately answer a fire call. Since radio communication is often affected by atmospheric conditions and frequently receivers develop internal trouble, it is necessary that periodic test transmissions be made to assure those on the receiving end that everything is satisfactory. These test transmissions should be made at one-half-hour or hourly intervals. A good procedure is to have crews who miss a test call for any reason to report in by telephone. If, after another test call the receiver is found to be out of order, either a repair man should be sent to put the receiver in order, or, if this is impossible and the fire hazard great, the crew should be stationed near a telephone until such time as the receiver can be repaired.

Fig. 1.—Loop antenna mounted on roof of pickup truck.

One way communication, where it can be used satisfactorily, simplifies the use of radio. It is considerably less expensive than two way communication. All that is necessary for a crew to have is a receiver with fixed tuning on the operating frequency and some type of receiving antenna. If the crew has a car or truck the antenna can be the normal car top antenna or a loop type antenna mounted on the car roof (Fig. 1). This latter type has an advantage in picking up signals at a greater distance.

Radio should never be considered a substitute for land line telephones, but merely a supplement thereto. In fact, the more intense the telephone system the better the radio system will function. An advantageous method is to have plug-in

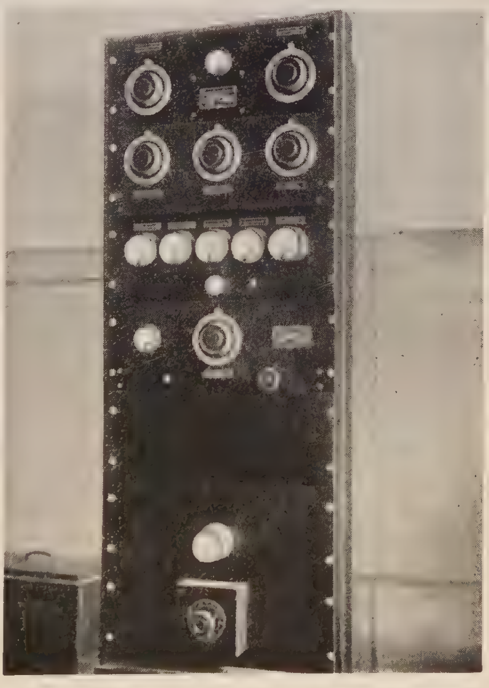


Fig. 2.—100-watt radiophone transmitter used by Superior Pine Products Co. Type Collins 150 BA. This transmitter has a reliable radius of 40 miles from the station to a moving car.

drops on the telephone line at frequent intervals and equip the crews with portable telephones. Thus, when a fire is located by the normal triangulation method, the dispatcher calls the nearest crew or crews and sends them off to the fire. They in turn can report in from the first telephone line they pass. When a fire is under way, constant reports are passed out by radio designating the progress made as reported by observation from the lookout towers. Often fresh break-outs in the rear of a crew can be detected by the lookouts and this information relayed by radio to the men on the fire.

Obtaining a Station License

The Federal Communications Commission of Washington, D. C., is the licensing authority. Before a station can be licensed it is necessary to determine the type and make of equipment to be used, the power output, and the location of the equipment. When this has been done the Commission may be written to for application blanks, which when properly filled out and passed on favorably will result in a construction permit. This construction permit allows 60 days in which to procure the equipment, install it, and get it ready to go on the air. When this has been done another application blank for station license must be filled out. Usually at this point the Commission will send an inspector to see that the station is in order and set up in accordance with the construction permit, and that a licensed operator of the proper grade is on duty. If all these details have been complied with a station license, which is good for one year, will be forthcoming. This license may be renewed from year to year simply by application.

The grade of operator's license necessary depends on the power output of the transmitter. For less than 50 watts output the operator may be third class. For 50 watts or higher he must have a second class license. The third class license application is rather simple and can be passed by almost anyone. However, for second class or above the operator must have considerable technical experience and must pass a rather rigid examination.

Determination of Power Needed

The amount of power needed to cover a given area depends to a considerable extent on the following: the frequency used, the general topography of the land, and whether or not communication is to be between fixed stations or between a fixed station and a moving car. For the present time at least the frequency is pretty well standardized at 2,726 kilocycles, or approximately 110 meters.

It is important to note that the power needed between two fixed stations over a given distance is usually less than that required between a fixed station and a moving car simply because a better receiving antenna and possibly a better receiver may be used in a fixed station. The range of a certain power output also varies between winter and summer months. In a region where the forest is accessible by car or truck it is an advantage to have the receiving equipment mounted directly in the vehicle. Under such an arrangement a minimum power output of 25 watts will satisfactorily cover a radius of 10 to 15 miles under all conditions. Fifty watts of antenna power will be satisfactory for a radius of from 15 to 25 miles and 100 watts for a radius up to 40 miles. When the radius gets beyond 40 miles the power output required goes up rapidly. All this, of course, with the understanding that the communication is from a fixed station to a moving car (Fig. 2). The maximum power output assignable for this type of work is 500 watts.

Two way communication in a territory readily accessible by car or truck may be considered in some respects a handicap. The present frequency assignment to transmit satisfactorily needs a minimum an

tenna length of 85 feet. This of course means a loss of time of anywhere from five to ten minutes in putting up the radiator, then possibly another five or ten minutes' loss in making the necessary contacts. If higher frequency were used the antenna of course could be shortened even to the point where it could be short enough for mobile communication. However, high frequency has its disadvantages in that, due to what is known as skip effect, regardless of the amount of power used the signal might fade out completely after more than a few miles' distance from the receiving station. While this signal may fade out over a short distance, it may be again heard at a distance of several hundred to several thousand miles away. The ultra-high frequency transmissions are extremely useful for mobile work where the radius does not exceed 8 or 10 miles.

Another disadvantage of two way communication is that it is necessary to carry some type of equipment to generate power for the transmitter. Whether this be batteries or a gasoline generator it adds considerable weight to the equipment. Generally speaking, where the territory is fairly accessible by truck or car two way communication is an unnecessary refinement.

Cost of Equipment

Cost of equipment of course depends to a great extent on the type used and power output. However, the following figures are approximate estimates for completely equipping transmitting stations with equipment of various power outputs that will pass the federal regulations:

25 watts output	\$650
50 watts output	850
100 watts output	1,200

These prices are minimum of course and can be increased considerably depending on the type of equipment used. The estimates include the transmitter, monitor, receiver, and installation of an antenna system. In addition will be the cost of car receivers and their installation. A suitable receiver can be purchased and installed in a car complete with loop antenna for approximately \$45. Portable transmitters can be purchased for a cost of approximately \$50 upward, the price depending on the power output.

Cost of Operating Station

Possibly the most expensive item of operation is the salary of a licensed operator. However, this expense may be considerably reduced when it is possible to train a man already in the organization who is taking care of other work, or to employ someone holding a license who in addition to his radio work would do other duties. Operation of the radio ordinarily takes only a very small part of the daily time. If a second class operator must be employed the salary would be approximately \$100 per month.

In order to comply with federal regulations it is necessary to obtain some frequency measuring service at periodic intervals, usually not less than once every two weeks. This consists of a test transmission to someone in the frequency measuring business who monitors the signal and furnishes an accurate report as to the exact frequency. Such service costs usually \$2.50 to \$3 per measurement.

Maintenance of the transmitter itself is usually very slight and possibly would not average over \$20 to \$25 per year. Individual car receivers, which are nearly always turned on constantly and subject to more or less rough usage, probably furnish the greatest source of maintenance cost. Each receiver will cost approximately from \$5 to \$10 annually for new tubes and repairs.

The first cost is probably the greatest item in any installation, especially if the operator is part of the regular organization and can carry on other duties along with the radio work. It is advisable to have someone trained in receiver repair.

Usually he can be trained within the organization, perhaps the operator or a telephone lineman already on the job. The latter would be more practical since he could repair a receiver at some distant point rather than have it sent back to the dispatching center.

Conclusion

The foregoing statement is written from experience gained in the application of radio over a four-year period in the flat woods region of Georgia. However, the information contained herein is applicable over a much wider area. Possibly the only places it would not apply satisfactorily are the mountain regions of the West and Northwest. In such regions portable transmitters with two way communication are almost an absolute necessity principally because of inaccessibility of the country.

Although the Federal Communications Commission has assigned a frequency that may be used for fire protection, this frequency is not assigned for this purpose as a particular service. In fact, the type service is Special Emergency, and herein lies a particular handicap. That is, in strict adherence to law, this type of communication would not be allowed until some extreme emergency arose and all other types of communication failed. Furthermore this one frequency would soon be crowded to a point of uselessness if a great many private forest owners decided to use this type of communication. Therefore it would be very desirable if the Federal Communications Commission could be prevailed upon to allot two or more frequencies specifically for this type of service. It would also be very desirable that these frequencies lie somewhere between the present frequency of 2,726 kilocycles and 3,000 or 3,100 kilocycles.

BREAKAGE REDUCTION IN FELLING REDWOOD

By EMANUEL FRITZ
University of California

Breakage in the felling of redwood often reaches and sometimes exceeds 20 per cent of the sound merchantable tree contents. It can be reduced by preparing layouts, by felling in more than one round, and preventing the crossing of timber. Where these precautions have been taken good crews have cut breakage to under 5 per cent.

BREAKAGE in the felling of coast redwood (*Sequoia sempervirens*) is probably greater than in the felling of any other American timber species. This is due, largely, to the great size and weight of the trees, the somewhat brittle character of their wood and to the rough steep ground on which most of them grow. Often there are sharp changes of gradient on the slopes within the length of a tree trunk. The resultant high points act as fulcrums over which the trunk bends and breaks. Redwood choppers call such terrain "short ground". Breakage is aggravated when the trees are "crossed". This is inevitable when all the timber in dense stands of tall trees must be felled in one round. After about one-half of the trees have been felled into the best natural "layouts," the remainder must be laid partly across those felled first. The impact of one trunk against another accounts for much of the breakage. Several methods have been devised and tried out experimentally for lowering the larger and more valuable trees mechanically, but, to date, none has proved economically feasible, and two have yet to be given a woods tryout.

Breakage Twenty Per Cent of Sound Volume

A study made by the author several years ago, in Humboldt County, California, indicated felling breakage to be very close to 20 per cent (19.42 per cent, to be exact) of the net sound merchantable tree scale. This study covered 29.04 acres scaling 4,099,778 board feet, net, Spaulding log scale, after deductions had been made for rot, rift cracks, hollow butts, and other natural defects. In other words, 796,004 board feet, log scale, of the total net scale of 4,099,778 board feet, was lost in the felling operation alone. The choppers (fallers) on this job were among the best the company had at the time, and the terrain was somewhat better than average. The area was steam logged, and both the slack line and high lead systems of yarding were used. This required that all the timber be felled in one operation. Of necessity, much of the timber was crossed; and, when heavy trees of from 250 feet to over 300 feet in length are crossed on steep, rough ground, breakage is certain to be great.

The loss of 20 per cent given above is for volume, or log scale. If breakage were only in the rough tops the loss in value might not be serious, but much of it is in that part of the trunk between the clear portion and the tops, and a smaller percentage is in the clear portion. On a Mendocino County operation, for example, a check scale showed that 4.54 per cent of the breakage was in the clear portion; 48.78 per cent in the portion between the clear logs and the top; and 46.68 per cent in that part of the top which would normally have been taken to the mill despite its lower grade. The total log scale in the Mendocino example was 1,332,035 feet, of which 143,133 feet, or 10.75 per cent, was broken in felling. Looked at in another way the breakage and utilized log scale divide as follows:

	Per cent
Utilized scale, 1,188,902 bd. ft. or	89.25
Breakage in clear portion	.48
Breakage between clear portion and top	5.24
Breakage in merchantable portion of top	5.03
Total scale, 1,332,035 feet or	100.00

The larger and more valuable trees, as is evident from Table 1, suffer greater breakage than the smaller ones. A goodly share of the breakage in the main trunk results from crossing—a heavy tree falling over another and either one breaking the other. Sometimes both are broken. It would appear, then, that, while the volume breakage is 20 per cent, the dollars and cents loss might be still higher. Table 1 gives also the breakage for each group of diameters.[1] It is to be noted particularly that over 60 per cent of all breakage is among trees measuring over 60 inches at the butt. These are the high-value trees.

Obviously, the amount of breakage is inordinately large, and it is unfortunate that the difficulties to be overcome are such as to have developed a large measure of complacency toward breakage in general. Twenty per cent breakage in such a valuable and limited timber as redwood is altogether too great, and should no longer be accepted as inevitable, particularly now that there is a possibility of materially reducing it.

Breakage Reduction by Chopping in Several Rounds and Preparing Beds

When tractor logging with modern equipment was introduced into the redwood region in 1935, it became possible so to reorganize the various operations that the heavy stands could be economically felled in more than one round and yarding made to follow felling by only a few days or weeks, or only two or three months at the most. Under the old method, often a year elapsed between felling and yarding. The mobile tractor and the closer sequence of felling and yarding now makes it possible to chop only as much timber as can be laid on the ground without crossing, to yarding it out, and then returning for another round of chopping and yarding. Wherever tractor logging has been adopted and where chopping is in two or more rounds, crossing of trees has been nearly eliminated and breakage materially reduced. This is a handsome cost credit toward the tractor investment.[2]

Bulldozer tractors for building tractor roads are necessary complements of yarding tractors, and, on close-knit operations, such machines are always near-by the choppers. When road building is systematically organized, the bulldozers become available for other work, such as preparing tree layouts. Soon after bulldozers became general in the redwood region, the choppers began calling for them for preparing beds or layouts where the natural ground indicated the probability of much breakage. This preparation usually requires only that hard high humps be leveled, windfalls rolled out, or logs or chunks rolled in to fill hollows. It is not necessary to make a perfectly smooth bed for the entire length of the tree; a series of landing points for the merchantable length of the tree, about 30-50 feet apart and all on the same gradient, as determined by eye, is all that is necessary. When a redwood tree is felled into such a prepared "layout," it is likely to land without a break for over 150 feet of its length. Ordinarily, the unbroken length averages, in big timber, about 100 feet.

It is not at all necessary to have a bull-

[1]Taken in part from Fritz, E. and C. R. Buell. An inventory of volume losses in logging redwood. Mimeograph. Pamph. California Redwood Association. San Francisco. July 20, 1936.

[2]Fritz, E. Tractor advantages in the redwood region. Jour. For. 35:919-928. 1937.

dozer tractor for preparing layouts. Choppers of the past were in the habit of spending considerable time, from one hour to a full day, depending upon the size and value of a tree, preparing a layout by hand. Hard humps were cut off with a mattock, interfering windfalls were cross-cut and rolled out with the aid of heavy jack-screws, and chunks were rolled into hollows, also by hand and jack-screws. Some choppers still do this, although other choppers, particularly where chopping has been put on a contract basis, feel they can make more money by using the time formerly spent on layouts for felling more trees. Experience and check scales show they are deceiving themselves while the breakage represents a greater loss of timber. To encourage the preparation of layouts, contract systems have been modified in various ways so as to reward the choppers for preventing breakage.

Reduction of Breakage on One Operation

How much the breakage can be reduced by avoiding crossing and by preparing good layouts is not yet known with any exactness. But, as an indication, there is given in Table 2 the thirty-two day record of one set of choppers, Louis Cox and Frank Haun, of the Caspar Lumber Company of Caspar, Mendocino County, Calif. This was spread over 60 days; due to illness and a hunting trip the men did not put in full time. The period covers the time they were engaged in chopping an area in the bottom of a gulch where the timber was heavy. The timber had been left to shade the tractor road during the summer, an important item in keeping down dust. The road was built through this timber to the back end of the area before chopping began. The area was given a light partial felling and the yarding progressed from the back end toward the landing—the reverse of the customary order. This system has

Table 1

MERCHANTABLE VOLUME AND FELLING BREAKAGE IN REDWOOD BY DIAMETER CLASSES
29.04 ACRES. HUMBOLDT COUNTY, CALIFORNIA
BOARD FEET BY THE SPAULDING LOG RULE

Butt diameter class	Trees felled		Net scale of sound merchantable contents (After deducting for natural defects)			Felling breakage (Merchantable material only)				Net car-scale of logs (After deducting for breakage and other operating losses)		
			Board feet			Board feet		Per cent			Per cent	
inches	Number	Per cent	Total	Per acre	Per cent	Total	Per acre	Of the class total scale	Of the total breakage	Board feet	Of the class total scale	Of the total car scale
12-30	114	17.0	108,601	3,740	2.64	15,259	525	14.05	1.92	66,890	61.60	2.35
31-36	92	13.7	171,251	5,900	4.18	22,947	790	13.40	2.88	120,456	70.36	4.24
37-42	95	14.1	308,210	10,610	7.53	39,346	1,355	12.76	4.94	218,552	70.91	7.69
43-48	90	13.4	436,421	15,030	10.63	65,021	2 239	14.90	8.17	320,530	73.45	11.27
49-54	62	9.2	387,777	13,350	9.45	70,161	2,416	18.09	8.81	280,558	72.35	9.87
55-60	66	9.8	506,649	17,440	12.33	99,759	3,435	19.70	12.53	351,445	69.36	12.36
61-66	45	6.7	452,477	15,580	11.04	86,738	2,987	19.17	10.90	313,724	69.34	11.04
67 and over	108	16.1	1,728,392	59,520	42.20	396,773	13,663	22.96	49.85	1,170,837	67.74	41.18
Total	672	100.0	4,099,778	141,170	100.00	796 004	27,410	19.42	100.00	2,842,992	69.34	100.00

been used with considerable success by Kelly B. McGuire, logging superintendent for the Caspar company.[3]

The bad leaners—those trees leaning away from a good layout—were left for the last round of cutting. Mr. McGuire insists that valuable leaners be felled opposite to their lean if this gives prospect of a better layout and less breakage, and if it is practicable.[4] Thus, when Cox and Haun began chopping, some of the more easily felled trees had already been cut and logged out. Nevertheless, in spite of this handicap, here is what they accomplished: nearly every tree of large volume was saved without a break for practically all of its merchantable length. The tree-by-tree record for the period appears in Table 2. This set of choppers fells about 400,000 board feet, Humboldt log scale, in a month.

The timber stands of Mendocino County average considerably less volume per acre than those of Humboldt County, but, in the bottoms of the gulches, the trees are often very large and stand close. Under such conditions the stands resemble those of Humboldt County. The data presented in Table 2 are applicable to Humboldt County conditions.

It is significant that, for the larger and more valuable trees, the unbroken lengths include practically all of each trunk that was merchantable, as indicated by the small amount of the breakage percentage data in column 6 of Table 2.

Influence of Contract System on Breakage

The choppers of the Caspar Lumber Company work on a contract system devised by Mr. McGuire. Under this system a man wins a good rate of pay when there is no breakage, but, if breakage occurs, his rate of pay for that tree is lower. The rate of wages per M feet varies with the breakage percentage. Wages are paid only for the unbroken length. When there is no breakage of merchantable material, the rate is high and is applied to the full scale of merchantable length. If the breakage is large the rate of wages is very low, and, furthermore, it applies only to the unbroken part. Thus, for tree no. 6, if there were no breakage, the wages for 18,272 feet might be $22, but actually the wages, because of the breakage, came to only about $10. The rate of wages becomes smaller at a more rapid rate than the increase in the breakage percentage. When this system was put into effect, breakage averaged 10 per cent; in one year it dropped to 7 per cent, and at present it is 4 per cent. This particular pay system is a stimulus to reducing breakage, and has caused the choppers to prepare good layouts instead of taking chances. This particular set of choppers is rated as one of the company's best, but other choppers of the same company do well also when they prepare good beds for their trees. It should not be assumed, because one operator's experience is featured here, that others are not experiencing similar results. Wherever timber is being felled without crossing, and where there is close supervision and an insistence on the choppers taking time to prepare good layouts, breakage has been materially reduced.

Large Breakage Should Not Be Taken as Inevitable

Breakage in the redwoods is not at all condoned by the operators, but it has gone on so long under the old system of chopping that it is taken almost for granted. Doubtless, the old acceptance of

[3]The writer is indebted to Mr. McGuire for permission to use the data given in Table 2.

[4]Several redwood operators use a tractor, when available, to swing valuable leaners into better layouts.

TABLE 2

TREE LENGTHS SAVED BY ONE SET OF CHOPPERS IN THE REDWOOD REGION AUGUST 15 TO OCTOBER 15, 1937, 32 WORKING DAYS

MERCHANTABLE MATERIAL ONLY, ROUGH TOPS EXCLUDED

MENDOCINO COUNTY, CALIFORNIA

	Net pay scale[3]				Breakage scale
Tree no. 1	Butt diameter Inches 2	Top diameter Inches 3	Unbroken length Feet 4	Scale (Humboldt) 5	Scale (Humboldt) 6
1	56	56	68	6,993	
2	51	29	164	8,501	
3	39	23	136	4,450	
4	57	39	116	8,748	
5	62	47	108	10,322	
6	90	38	120	16,201	2,071[1]
7	27	21	84	1,513	
8	40	26	132	4,884	
9	61	52	116	11,929	
10	58	47	80	7,646	
11	54	31	136	7,808	
12	35	26	116	3,326	
13	43	35	68	3,525	
14	45	40	84	4,823	
15	95	30	160	20,240	
16	30	22	96	2,048	
17	31	29	48	1,377	
18	31	23	40	996	
19	42	27	124	4,587	
20	67	39	104	9,940	
21	38	22	132	3,785	
22	64	47	104	10,695	3,940[2]
23	62	28	168	10,640	
24	22	18	40	482	
25	53	37	108	7,469	
26	48	30	148	7,672	
27	83	52	144	22,045	
28	41	33	72	2,994	
29	45	30	112	5,216	
30	90	60	188	34,319	
31	76	54	132	18,997	
32	21	19	36	435	
33	112	69	184	50,103	
34	94	53	140	25,597	
35	24	22	24	358	
36	30	22	88	1,878	
37	58	46	116	10,276	
38	43	34	60	2,794	
39	49	30	108	5,599	
40	24	21	28	417	
41	38	26	112	3,664	
42	58	34	128	8,853	
43	28	21	48	865	
44	41	24	116	3,798	
45	53	42	92	6,938	
46	21	18	48	580	
47	53	32	140	8,038	
48	68	37	132	11,694	
49	56	46	72	5,894	
50	49	36	96	5,512	
51	50	38	76	4,814	
52	46	35	100	5,184	
53	47	42	68	4,307	
54	39	21	100	2,868	
55	30	22	72	1,536	
56	36	20	108	2,691	
57	36	33	48	1,776	
58	30	26	36	897	
59	84	71	100	20,400	
60	48	44	64	4,426	
61	70	42	140	14,397	
Total				480,760	6,011
Total breakage scale					6,011
Breakage percentage for the period					1.23

[1]Butt dia. 38 inches, top dia. 31 inches, length 56 feet.

[2]Butt dia. 47 inches, top dia. 32 inches, length 76 feet.

[3]Column 2. This butt diameter figure is taken inside the bark 20 feet from the actual butt end to get away from the common butt flare. The bark is chopped away and the diameter is read from a scale stick laid across the prone trunk and from between plumbed lines.

Column 3. Top diameter is taken just back of the first break and where a clean cross-cut can be made.

Column 4. The overall length, from the actual butt end to the point at which top diameter was read, less 6 inches for each 20 feet for trimming allowance.

Column 5. The Humboldt scale is 30 per cent off the Spaulding scale and is in common use in the redwood country to obviate the necessity of determining the cull for rot, internal felling cracks and other defects. The scale is read from a specially prepared table reading total scale for a trunk of any length and for its mean diameter—the sum of the butt and top diameters divided by two.

Column 6. The merchantable material beyond the first break is scaled by the same method used on the unbroken length. Its scale is used to determine the wage rate for the tree. Its small volume is evidence that felling breakage was very low. Only two trees were broken. The rest of the tree tops, although frequently over 75 feet long, are so very rough as to make them unmerchantable.

heavy breakage is due in large part to the heavy yield per acre, which still remains big even after 20 per cent of the original volume is broken. Rising costs, and shrinking timber reserves, however, are directing more attention to the reduction of this loss. If a present-day chopping breakage of 20 per cent is only cut in half, it means not only reduced unit costs, but it saves acreage. It would be equivalent to saving 10 acres of timber for every 100 acres logged plus the cost of its development.

Until someone invents a practicable method of lowering large trees more gently, the best means of reducing felling breakage are (1) chopping in two or more rounds to avoid crossing, (2) insisting on the preparation of good layouts, (3) close supervision, and (4) a sliding scale of wages based on quality of work.

Forrest H. Colby

1869—1938

FORREST H. COLBY, since 1921 an associate member of the Society, died on February 11 in his 69th year.

Mr. Colby was born in Bingham, Maine, February 4, 1869. Since the age of 18 he followed woods work, lumbering, and forestry. In 1917 he was appointed Forest Commissioner for the State of Maine and served until 1921, when he became associated with the Woodland Department of the S. D. Warren Company. Later he became affiliated with the Maine Seaboard Paper Company. For a number of years he maintained a private office in Portland as a consultant in forest management, lumbering, and pulpwood supply.

He was well known throughout New England for his long years of effort to promote forest conservation and good logging practices.

EFFECT OF DEPTH OF SOWING ON NURSERY YIELDS OF BLACK LOCUST

By H. G. MEGINNIS

Southern Forest Experiment Station

With the development of the soil conservation program black locust has become a very important species. The yield of seedlings from a given number of black locust seed is notoriously low. Although few data have been available, it has long been suspected that the depth at which the seeds are planted affects the seedling yield. The results obtained by Mr. Meginnis seem to justify the recommendation that black locust seed be covered ¼-½ inch when grown under conditions comparable to those under which the study was made.

RECENT experience at nurseries producing black locust seedlings in large quantities for field planting has focused attention on the low percentage of trees obtained. Replies from 42 black locust nursery operations in 17 states in response to a questionnaire sent out in 1935 indicate that on an average less than 8 per cent of nursery-sown seed produce seedlings. In order to investigate some of the major causes for these low seedling yields, studies were carried on by the Southern Forest Experiment Station during 1934, 1935, and 1936 at several nurseries near Holly Springs, Miss.

In these studies, depth of sowing was one of several cultural practices investigated because of its suspected influence on germination and the subsequent number of trees obtained; in nursery practice, depth of drilling was observed to vary widely, especially in large-scale operations employing mechanical sowing equipment. Furthermore, a special study of this factor was prompted by (1) observations indicating that surface crusting of the soil and other circumstances which prolong germination and emergence of the seedlings markedly reduce yields; and (2) the fact that much seed is hard-coated and hence very dependent on an ample supply of soil moisture in order to germinate.

Previous Recommendations

Many investigators have stressed the importance of planting tree seed at the proper depth, although a review of the literature on this subject discloses a lack of unanimity in recommendations applying to the sowing of black locust seed. Mattoon (3) recommends covering seed to a depth of ½-inch; Maddox (2) suggests sowing in drill rows 2 inches deep and 2 inches wide with the soil leveled off, thus covering seed with ½-¾ of an inch of soil; and McIntyre (4) recommends covering seed ¾-1 inch deep. Miller (5), on the other hand, states that covering to a depth of 2 or 3 inches is about the proper covering for black locust seed. Toumey and Korstian (6), although not referring specifically to black locust, recommend as a general practice a soil covering from 1 to 4 times the average diameter of the seed, depending on the locality and the character of the soil. Furthermore, they point out that a deep covering is more acceptable in sands, loams, and in dry soils, whereas a shallow covering is preferable in clays and wet soils. Laurie and Chadwick (1) make a similar observation and state that the oxygen requirement of seed largely determines the depth of planting to be employed in soils of varying texture and moisture content.

Experiments on Depth of Covering

At Holly Springs, the first depth-of-seeding trials were made during the 1934 growing season on a fine-textured silty clay of the Memphis series, derived from weathered loess. This soil, although fertile, crusts readily and must be worked judiciously after rains in order to maintain it in good physical tilth. A mechanical analysis showed in the upper 6 inches 49 per cent silt, 37 per cent clay, and only 14 per cent sand.

The nursery site was plowed and harrowed on May 22 and was reworked on June 11. On June 22, 5 days after a 3-inch rain, samples of black locust seed[1] were sown in a randomized block of 5 drill rows, 24 inches apart and 25 feet long. In one drill row, seed were sown on the surface and left uncovered, while those in remaining rows were covered with well-firmed soil to depths of ¼, ½, 1, and 2 inches, respectively. On June 26, a second block of 4 drill rows, similarly spaced, was sown to seed of the same lot and covered with ¼, ½, 1, and 2 inches of soil, respectively. In each treatment 350 seeds were sown.

On both sowing dates, the surface inch of soil was relatively dry, but there was abundant capillary moisture at a depth of 2 inches. On June 29, 7 days after block 1 was sown and 3 days following the sowing of block 2, a rain of 1.26 inches fell. Subsequent precipitation for July totaled 2.75 inches and that for August 1.67 inches. Although rainfall for June, July, and August amounted to only 9.43 inches, or about 78 per cent of the normal for the locality, the rains were well distributed and fell in amounts and at rates that permitted maximum infiltration into the soil; consequently throughout the growing season there was ample water for growth and at no time did seedlings suffer noticeably for lack of moisture.

Figure 1 shows the number of seedlings alive on various dates after sowing, for all treatments and both blocks. Block 1, sown when the surface soil was comparatively dry, showed the greatest number of living seedlings from the 2-inch depth of covering through July 3. The rain of June 29, however, enabled seed sown at the shallower depths to germinate; and from July 8 on, the number of seedlings alive on successive dates was greatest from the ¼-inch depth of covering and least from the 1- and 2-inch depths. In block 2, which was sown shortly before the rain of June 29, the number of living seedlings was on all dates in inverse ratio to the depth of covering employed. It will be noted that in both trials germination and seedling survival were almost identical for the 1- and 2-inch depths of covering.

Total germination throughout the growing season together with the final yield of seedlings as tallied on September 16 are shown in Table 1. The sowings in block 2 gave markedly better germination and greater seedling yields than those in block 1, presumably because the moisture

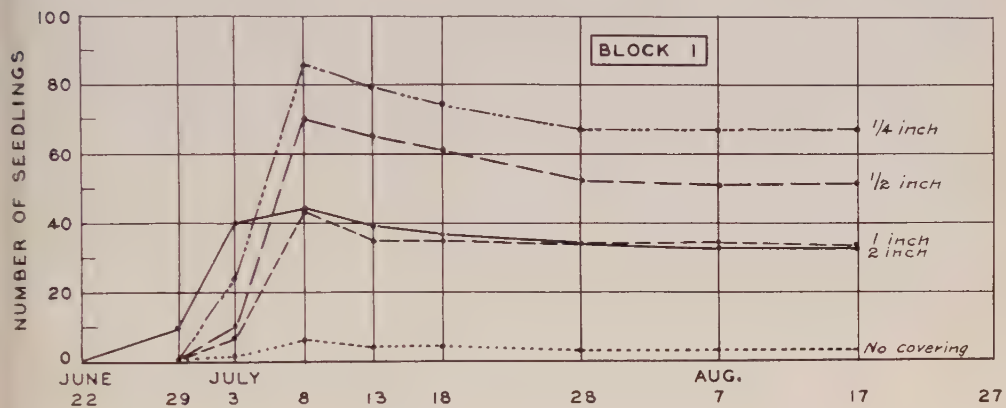
Table 1

COMPARATIVE GERMINATION AND SEEDLING YIELDS FROM BLACK LOCUST SEED COVERED WITH SOIL TO VARYING DEPTHS

Block	Depth of soil covering	Germination per cent	Tree per cent
	Inches		
1	None	2.0	0.6 ± 0.4
	¼	27.4	17.7 ± 2.0
	½	21.4	13.4 ± 1.8
	1	12.6	9.4 ± 1.6
	2	12.6	8.9 ± 1.5
2	¼	42.0	26.6 ± 2.4
	½	35.4	20.6 ± 2.2
	1	33.1	13.1 ± 1.8
	2	27.4	13.7 ± 1.8

[1]The seed, gathered locally the previous summer, and treated with sulphuric acid on May 14, showed in preliminary tests a mean germination of 89 per cent after 20 days. For details of this treatment see U. S. Dept. Agr. Circ. 453, "Sulphuric acid treatment to increase germination of black locust seed," November 1937.

conditions favored more prompt germination. In both trials, however, the greatest yields were obtained from the ¼-inch depth of covering and relatively poor yields from the seed covered 1 and 2 inches. In both trials the seedling crop was cut approximately in half by the 2 greater covering depths. A comparison of tree-per cent values for the various treatments in terms of the standard error of the difference indicates that in both trials differences between ¼-inch and ½-inch depths of sowing are within the limits of experimental error and hence are not considered significant. Differences between ¼-inch coverings and either 1- or 2-inch depths of sowing are real, however, amounting to more than 3 times the respective standard errors of the difference.



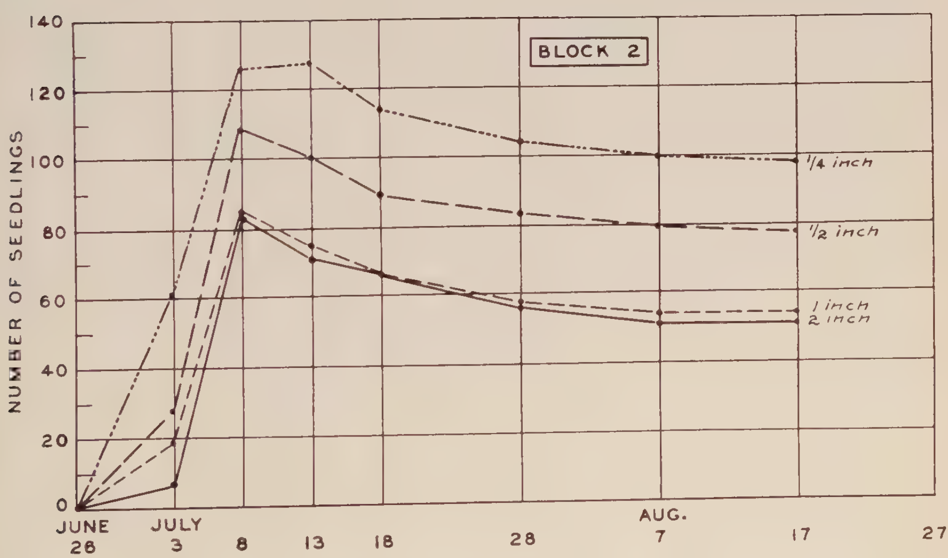


Fig. 1.—Number of black locust seedlings alive on various dates from seed sown at varying depths. 1934 season, Holly Springs, Miss.

Depth-of-covering experiments were repeated during the 1935 nursery season, but the results are inconclusive owing to a protracted drought during the 2 months following sowing. During this time only 1.66 inches of rain fell, and most of this as scattered, ineffective showers. As a result, germination was not only greatly retarded but experimental treatments were also further impaired by blowing and drifting of the loose, arid soil.

During the 1936 season, additional tests were made on a light sandy loam soil of the Thompson series adjacent to a small creek draining wooded uplands. This friable and porous soil is of mixed alluvial and colluvial origin, being formed in part from outwash from adjacent slopes and in part from sedimentary deposits from stream overflows.

The area was plowed and harrowed on June 5 and again on June 10. On June 11, samples consisting of 1,250 sound seed[2] were sown in each of 25 plats arranged in a 5 x 5 Latin square, thus providing 5 replications of each treatment. Each plat was 60 square feet in area and was composed of 5 drills 10 feet in length and 18 inches apart.

On June 10, the day before the seed were sown, a light shower totaling 0.15 inch fell at the nursery site, but no rain of consequence occurred until July 2, when a 3-inch rain fell. On the sowing date the surface soil was dust-dry to a depth of ¼-inch, and 4 days later the soil was quite dry throughout the upper 1½ inches. These sowings were therefore without adequate moisture for germination for a period of 21 days. After the heavy rain of July 2, which fell at a rate that precluded complete absorption by the soil, only 1.05 inches of precipitation fell during the remainder of July; and only 0.79 inch of water fell in August. Rainfall for June, July, and August totaled only 5.25 inches, or only 44 per cent of the 50-year average for the locality. On the whole, the 1936 season was one of scanty moisture with rainfall far below that necessary for normal plant growth.

On September 9, a tally was made of the seedling crop. The results expressed as tree per cents were analyzed by analysis of variance, whereby total variation was divided into its component parts and the significance of each source of variance determined (see Table 2).

As shown in Table 2, treatments were a highly significant source of variation but rows and columns were not significant, indicating that in this particular experiment, soil heterogeneity was not an important factor.

In Table 3 are summarized mean tree per cents for each depth of covering together with the appropriate standard error of the difference between treatment means. Best results were obtained from a soil cover ½-inch thick, 10 per cent of the seed so covered producing plantable seedlings. Covering with ¼-inch of soil gave an average tree per cent of 7.84 but the difference between this yield and that when seed was sowed ½-inch deep is not significant. Covering ½-inch, however, gave significantly better yields than any of the remaining treatments. Although covering 1 inch significantly reduced yields, this treatment gave comparatively good results compared with those from seed covered 2 inches. The reasons for the exceedingly poor yields from a 2-inch cover are not clear; and this result presents somewhat of an anomaly, inasmuch as seed sown at this depth gave much better yields on the heavy soil used in the 1934 trials. The rather low yields from all depths of covering in the 1936

[2]The seed, obtained from a large nursery at Coffeeville, Miss., and given an optimum 1-hour sulphuric acid treatment early in June, showed in preliminary tests an average germination of 93 per cent in 18 days, using peat moss as the germinating medium.

tests are logically attributable to the effects of drought and the long time the seed had to remain ungerminated in the soil before the first rain.

Discussion and Application

The results confirm the original premise that depth of sowing is likely to be an important determinant of seedling yields in producing black locust planting stock. Furthermore, the results seem to justify the recommendation that black locust seed be covered ¼-½ inch when grown under conditions comparable to those of the study. This general conclusion seems warranted in spite of the fact that the tests were limited in scope, inasmuch as trials during both seasons, under widely diverse growing conditions and on very different soils, gave consistent results. The heavy soil used in 1934 might be expected to favor shallow sowing, while the light soil used in 1936 should favor deeper planting; but the shallow sowing gave best results under both conditions. Although special circumstances, such as the use of a light, permeable soil subject to wind erosion, might justify relatively deep sowing, the indications are that under average conditions shallow drilling is safer, particularly where watering facilities are available and the soil moisture can be regulated during the germination period.

In nursery practice, sowing seed at shallow depths not exceeding ½-inch calls for a careful adjustment and operation of mechanical seeders as well as the proper preparation and leveling of the seedbed prior to sowing. As an aid to uniform covering, the soil should be friable and practically free of clods, while the nursery area should be harrowed and tilled until all low places are filled and all humps are leveled off. Rolling the bed as a final measure prior to sowing not only will assist in leveling the site but also will make it easier to check up on the performance of the seed drill, that is, on the depth at which the seed are being dropped and covered in the drill row.

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Table 2

ANALYSIS OF VARIANCE OF BLACK LOCUST TREE PER CENTS FROM DEPTH-OF-COVERING NURSERY TRIALS

Source of variation	Degrees of freedom	Sum of squares	Mean square	Standard deviation	F[1]	Probability of significance[2]
Treatments	4	279.0944	69.7736	8.3531	21.7750	Highly significant
Columns	4	13.6224	3.4056	1.8454	1.0628	Not significant
Rows	4	31.1144	7.7786	2.7890	2.4276	Not significant
Remainder or experimental error	12	38.4512	3.2043	1.7901		
Total	24	362.2824				

[1]F value represents the ratio of a given mean square to that of the remainder.

[2]Considered highly significant if probabilities are less than 1 chance in a hundred that the F ratio may be equaled or exceeded in random sampling; considered not significant if probabilities exceed 1 chance in 20.

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TABLE 3

COMPARATIVE SEEDLING YIELDS (MEAN TREE PER CENT) OBTAINED BY COVERING BLACK LOCUST SEED WITH VARYING DEPTHS OF SOIL

Check—no covering	2-inch covering	1-inch covering	½-inch covering	¼-inch covering	Standard error of difference	Difference required to give a 20:1 probability of significance
2.88	0.92	7.10	10.00	7.84	1.13	2.61

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Several correspondents are seeking these back numbers. Those having them for sale are requested to write to the Business Manager at Washington.

THE FLOW OF LIQUID THROUGH RADIAL RESIN CANALS

By HARVEY D. ERICKSON[1]
University of Minnesota

It has long been suspected that resin canals in woods possessing them exert an influence on the movement of liquids in such woods. In the following article several methods of demonstrating and measuring the flow of liquids through resin canals are described. Not all the sections of woods having resin canals show visible evidence of flow through the canals and the number of open canals in a given area varies not only in different species but in different sections of the same wood.

RESIN canals may play a role in impregnating wood with preservatives, particularly with creosote. Their efficiency has been believed to depend upon the species, the condition of the canals, heartwood or sapwood, the kind of preservative, and the temperature. Studies on rate of liquid flow through wood have been few and more or less general in character. Liquid penetration studies have been more extensive. Together, they form the basis for a better understanding of the influence of resin canals on liquid movement by pressure.

Tiemann (8) by use of a soap film on the surface of the section and applied air pressure found that some of the longitudinal canals were more or less open. Weiss (9) and Teesdale (7) believed that the ease of treating different species was correlated with the number of radial resin canals especially in the sapwood. Teesdale (7) stated that the nonresinous character of the wood was also a determining factor.

Scarth (5) reported that resin canals were the chief means of longitudinal penetration in jack pine sapwood but not in the heartwood where they were usually blocked by resin or tylosoids; however, other workers (4, 6) believed that resin canals were only partly responsible for longitudinal flow through these woods.

In a recent report, Erickson, Schmitz, and Gortner (1) state that the longitudinal permeability of southern pine sapwood sections 1 cm. thick was not appreciably affected by the resin canals. In an investigation (2) on the directional permeability of woods, they conclude that radial flow of water through thin sections of sapwoods seemed to occur chiefly through the radial resin canals when they were present. For the corresponding heartwood sections, with a few exceptions, no general conclusion could be reached. Considering the large variation in rate of flow between some sections of the same piece of wood or of different species it seemed reasonable to expect that flow through radial resin canals could be demonstrated with certainty.

Apparatus and Experimental Procedure

A tank of compressed air equipped with a reduction valve and a pressure gage, a brass supply tank for the water and a brass disc, with a 1.5 cm. circular opening, attached to the supply tube by the proper unions constituted the main apparatus. Bolts and metal bars pressed a metal collar firmly against the section of wood and the ensemble against the brass or basal disc. In determinations where carbon tetrachloride was used, a short glass tube of a diameter greater than the opening in the disc was employed between the section and the cross bars.

The tangential sections, about 1.25 mm.

[1]Now Assistant Professor of Forest Utilization, West Virginia University.

thick, were humidified, then evacuated for one-half hour, including 15 minutes above water, and allowed to remain submerged in water at least 15 minutes before testing. They were of the same lot as those used in the preceding work (2), several of them actually had been used in the experiments. In many cases the application of sufficient pressure caused the water to issue from the resin canals in jets or streams and demanded no other technique except to keep the surface layer of water on the section as thin as possible by capillary drainage and a vertical position of the disc. A blast of air helped to remove water on the surface and to allow a weak jet to appear.

Other methods were used for the detection of a slow stream of water from a resin canal. The disc with the section on the lower side was immersed into butyl alcohol over water. Because water has the greater specific gravity and the interfacial tension is very low, the flow appears as a slow downward stream or a series of small droplets.

Carbon tetrachloride placed on the section in the glass tube afforded another technique. Because the water has the lesser specific gravity, it tends to rise; but this is inhibited somewhat because the interfacial tension in this case is about 31.4 ergs per sq. cm. which is large enough to discourage very weak jets and cause them merely to flow in the water layer at the surface from which drops arise as liquid accumulates. Tilting the disc at an angle prevented this somewhat. The surface water layer did not appear to be removed by the carbon tetrachloride.

In another method a thin layer of water was allowed to accumulate on the section, the disc was held horizontally, or at the angle best suited to obtain the desired result at any given spot, and the surface was observed by direct light. Since the momentum of a stream causes turbulence and a small localized convexity on the surface of the thin water layer, it brings about a reflection of light at an angle different from that of the flat surface and hence becomes differentiated.

It was necessary to stain the resin canals in order to demonstrate photographically that flow was actually through the resin canals. Acid fuchsin and potassium dichromate—haematoxylin were found to be efficacious. In the latter method the section was placed successively in dichromate solution (4 to 5 per cent, the time adjusted to the particular experiment), in water, in fresh one per cent water solution of haematoxylin until the section began to darken, and finally in water to remove excess dye. Eventually the resin canals appeared brown to blue-black. The removal of a very thin layer of the colored surface produced a relatively unstained background for sharper contrast.

Experimental Results

Figure 1 shows the jets of water obtained with application of pressure on sections of woods. This section is from the springwood of the sapwood of shortleaf pine stained by the dichromate-haematoxylin method. Note the resin canals (fusiform rays?).

These jets actually originated at the resin canals as revealed by a hand lens, by marking around the jet with a sharpened pencil and later making a close study, by staining the canals and determining the origin of the jets during actual flow, and by photographing. In each case a resin canal was at the base of the jet.

Figure 2 shows the results observed on a number of sections. The section was 1.25 mm. thick (2 and one-half annual rings). It is apparent that the dark spots are resin canals or fusiform rays because of their shape, distribution, and size as compared to the ends of the wood rays, a number of which are fairly distinct in the upper half of the section. Resin ca-

nals are visible at the base of at least 6 jets in Figure 2. Adverse optical effects and insufficient staining account for the obscure origin of the remainder of the jets.

At the base of each of several jets shown in Figure 2 there is visible a cone of water through which the jet emerges or which surrounds the main stream of water as it leaves the orifice of the resin canal. This is merely the expression of the surface tension effect between the expelled stream of water and the film of water on the surface of the section.

Occasionally some resin canals showed visible conduction of liquid only after the pressure had been applied for some time. The section shown in Figure 2, for example, had been in the apparatus once before; at 35 lbs. per sq. in. only one canal was open and the flow was 0.75 cc. per minute. The section was removed and placed in water for 5 hours. On second trial 7 jets were observed and the

Fig. 1.—Streams of water shooting from a tangential section of shortleaf pine sapwood. Some of the fusiform rays are visible. Natural size.

number increased to 10 within one-half hour, during which the pressure was on and off three times. A second section showed no effective canals at 70 lbs. pressure until after 15 minutes when one jet appeared which flowed at the rate of 0.34 cc. per minute. A section of tamarack heartwood gave similar results. Perhaps the particles of resin obstructing the canals were gradually dislodged and forced out leaving the canals in a more or less open condition.

The pressure applied materially influenced the number of effective resin canals of some sections. In a section of summerwood of shortleaf pine sapwood 3 active canals existed at 25 lbs. pressure; at 50 lbs., 5 streams could be detected. In butyl alcohol, 6 jets were immediately seen. After removing from the alcohol and increasing the water pressure to 75 lbs. a total of 10 effective canals were observed. One jet spouted from the section; the others were discernable by the light-reflection method. With a section of springwood from tamarack sapwood one jet was obtained at 35 lbs. pressure and two jets at 50 lbs. A section of summerwood from tamarack heartwood showed 3 jets at 15 lbs., 7 jets at 35 lbs., and 8 jets at 75 lbs. pressure.

A few sections that showed visible evi-

Fig. 2.—A section of coast Douglas fir sapwood with jets of water issuing from the resin canals which have been stained with acid fuchsin for contrast. Five and one-half times natural size.

dence of effective resin canals at 75 lbs. pressure were subjected to a pressure of 150 lbs. per sq. in. for 15 minutes in a different apparatus. A section of springwood of loblolly pine sapwood thus treated showed 4 effective canals (by reflection of light) when returned to the regular apparatus at 75 lbs. pressure. The higher pressure actually opened some of the canals. Similar results were obtained with a section of summerwood of slash pine sapwood but jets were actually obtained. A section of summerwood of coast Douglas fir heartwood and one of tamarack sapwood, however, failed to respond in this way or alter appreciably in rate of flow.

The volume of water flowing through a resin canal was measured with a fair degree of accuracy for several sections of wood. A single stream from the section of longleaf pine sapwood under 30 lbs. pressure flowed at the rate of one cc. per minute. The flow of a jet from coast Douglas fir sapwood under 45 lbs. pressure was 3.2 cc. in 5 minutes after a preceding interval of 5 minutes. After one-half hour the rate was 2.5 cc. in 5 minutes and after 1 hour 2.2 cc. in 5 minutes. Thus, the rate of flow in this case decreased with time of continuous flow. The jet from another section flowed at the rate of 1.7 cc. in 5 minutes (initial rate of flow), 1.8 cc. after 5 minutes. 1.64 cc. after 35 minutes, and 1.86 cc. in 5 minutes after one hour of flow. In this case there was a shift or fluctuation in rate of flow. A section of summerwood of tamarack heartwood under a pressure of 75 lbs. per sq. in. had initially 8 jets, producing 3.9 cc. per minute, but 45 minutes later only 7 jets giving 3.4 cc. per minute. The eighth canal which was weak at the outset apparently became clogged after a time.

Jets, when present, usually contributed the major portion of the flow. In two experiments, however, the flow of water through the section was appreciable in addition to the combined volume of the visible jets. This was true with one section each of white spruce sapwood and slash pine sapwood.

Not all the sections from woods with resin canals showed visible evidence of flow through resin canals. Of the 25 sections tested 8 failed to demonstrate adjutage flow by resin canals within one-half hour at 75 lbs. pressure. These resistant sections were not confined to any one wood but in tamarack heartwood and sapwood the very resistant sections outnumbered the permeable ones.

The woods used in this experiment and the number of sections of each are as follows: Springwood of loblolly pine sapwood 3; springwood of longleaf pine sapwood 1; white spruce sapwood 1; coast Douglas fir sapwood 5, heartwood summerwood 1; summerwood of shortleaf pine sapwood 3, springwood 1; springwood of slash pine sapwood 2; tamarack sapwood 3; tamarack heartwood 5. Where the source of the section with respect to the part of the annual ring is not stated both springwood and summerwood were present.

Discussion

The foregoing experiments explain the occurrence of certain variations and fluctuations in radial rate of flow by pressure through thin sections of woods with resin canals (2). The large variations observed within sections of the same wood (possessing resin canals) were attributed chiefly to the influence and effectiveness of radial resin canals in pressure permeability. This conclusion is verified by the data of the experiments reported here. However, variations below certain rate of flow values which may approximate the average for either sapwoods or heartwoods lacking resin canals, cannot properly be explained on this basis only.

The fluctuations in rate of flow through a single section noted in a few cases (2)

were duplicated by actual observations of the behavior of flow through resin canals. This was true with some sections of certain woods such as tamarack and white and black spruce where flow was initially slow or moderate at high pressure, but after less than half an hour the rate of flow usually was very markedly and often quite suddenly increased.

The fact that in sections of very low permeability no effective resin canals could be detected by the methods employed does not imply that the resin canals were totally non-conductive. It seems probable that they might allow water to pass through them in amounts so small as to remain undetected. A certain section of tamarack sapwood had no visibly effective canals but the water came through slowly at three limited areas of the section while the remainder of the section appeared to accumulate very little water on its surface.

Obviously, the percentage of potentially effective resin canals is small. (In the exposed area of a section of southern pine 55 resin canals were counted. The number of canals in species other than the pines is usually less.) The non-effective canals evidently are clogged with resin or are blocked by tylosoids to various degrees (cf. literature review) or by the incomplete separation of parenchyma cells in both the sapwood and the heartwood (3). It is apparent that when a section has considerable flow through resin canals, the average rate of flow of several sections may be misleading if the minimum and maximum values are not taken into consideration. Such values have been presented in data on directional permeability (2).

It is recognized that these results may not be obtained when experimental conditions are altered, e.g., thicker sections, higher temperatures, different liquids, etc. The effect of such factors must be determined by further research.

Summary

A few of the radial resin canals of some sections of woods may conduct water and greatly increase the pressure permeability of such sections as compared to sections without resin canals either actually or in effect. Streams or jets of water issuing from the resin canals have been observed and photographed. When the flow through resin canals was large it accounted for nearly all the flow through the section. When resin canals were not visibly effective the rate of flow was comparatively very small.

The observations and data of the behavior of streams of water emitting from the canals coincide with the variations and fluctuations that were noted and discussed in investigations on radial permeability (2).

Several methods that were used for the detection of flow by pressure through resin canals are described, and the flow through individual resin canals was measured in several cases. The rates of flow varied greatly.

Acknowledgment

The author is grateful to Dr. A. J. Bailey for aid in the photography.

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THE Southern Forest Survey has now completed sufficient analysis of its cruise of 213,000,000 acres of land in the Lower South to present a brief preview of some of its findings.

Three outstanding findings of the inventory phase of the Survey are: (1) that 125.000,000 acres, or 59 per cent of the land surface, is in some stage of forest growth; (2) that 97,000,000 acres of this vast area of forest is in second-growth timber; and (3) that hardwood species, which are to be found in a significant proportion on 65 million acres, make up 44 per cent of the total sawtimber volume in the region.

The total sawtimber volume found in the Lower South, which includes the sawtimber volume in all sound pine trees at least 9 inches in diameter at breast height and in all sound hardwood trees at least 13 inches d.b.h., was 264 billion board feet, of which 147 billion feet was pine and 117 billion feet was hardwood. The additional volume in under-sawlog-size trees, which includes only the smaller trees at least 5 inches d.b.h., is estimated to be 454 million cords net, of which 34 per cent is pine and 66 per cent is hardwood.

BRIEFER ARTICLES AND NOTES

Duke University to Offer Graduate Work in Forestry

A graduate school of forestry will be launched at Duke University next fall, culminating seven years of preparation toward this end. It will be the third graduate school of forestry to be established in the United States, the others being at Yale and Harvard universities.

Dr. Clarence F. Korstian, who has been Director of the Duke Forest since 1930, is Dean of the newly projected school. The school will begin with a full-time faculty of seven professionally trained foresters, in addition to two instructors in botany from the regular university faculty and an administrative staff. At the beginning of the second year of the school's operation, as the first-year class advances, the faculty will be enlarged to provide instruction in additional courses.

Present members of the school's faculty, in addition to Dean Korstian, who is professor of silviculture, are: T. S. Coile, assistant professor of forest soils; Dr. Ellwood S. Harrar, associate professor of wood technology; Dr. Paul J. Kramer, assistant professor of botany; William Maughan, associate professor of forest management; Francis X. Schumacher, professor of forestry; Roy B. Thomson, associate professor of forest economics; and Dr. F. A. Wolf, professor of botany.

The Duke forest of 4,938 acres directly adjoins the university campus, providing the school with a practice, demonstration, and experimental forest that is entirely unique in this country in regard to its proximity to the forest school. Laboratory and greenhouse facilities for the school are provided in the university's large biology building.

In addition to the designated forest ar
adjoining the school's laboratories, a 30
acre arboretum is being developed
which 54 species of trees have alrea
been planted.

There will be no undergraduate degr
offered by the school. The school wi
accept for entrance men who have r
ceived their bachelor's degree from ot
er universities, as well as those comple
ing the pre-forestry course at Duke. T
Master of Forestry degree will be ava
able to such men in one or two years d
pending upon their previous trainin
The M.A. and Ph.D. degrees will be giv
for work in the scientific phases of fo
estry through the university gradua
school. For this work the school of fo
estry staff will serve as members of t
forestry division of the graduate schoo

The new forestry school is expected
fill a definite need, particularly in t
south where there has previously be
no forestry school of graduate rank. T
vast area of forest land in the South a
the great economic and social importa
of southern forests emphasizes the ne
for a school where men may obtain
vanced training under southern conditi
for work in this southern region.
only in the South but all over the Un
States a greatly increased attention
forestry problems and soil and wa
conservation during recent years has st
ulated the demand by both governme
and private organizations for well-trai
foresters.

Summer school courses in forest
veying and forest measurements will
given, and during the two semesters
the regular school session courses will
conducted in the fields of silvicul

'orest management and valuation, forest ›oils, forest mensuration, dendrology, vood anatomy, forest economics, forest ıtilization, forest-tree physiology, forest ›athology, forest entomology, and game nanagement.

'ORESTRY MEETING IN CONNECTION WITH 'HE THIRTY-NINTH ANNUAL CONVENTION ›F THE ASSOCIATION OF SOUTHERN AGRICULTURAL WORKERS

The meetings of the Forestry Section ıf the Association of Southern Agricul- ıral Workers were attended by more than 30 delegates. This was the best meeting ver held by the Forestry Section. The rogram presented on the afternoon of ebruary 2 and the morning of February covered timely subjects with respect › recent forestry legislation and the de- elopment of the pulp and paper indus- y in the South.

R. W. Graeber, Extension Forester ›r North Carolina, presided at the meet- ıgs. In his opening address, Mr. Grae- er stressed the importance of forestry ıd forest practices in the agricultural rogram for the South. He stressed par- ıcularly that foresters as a group had ven too little attention to the large creage represented by the farm wood- nds. Fifty per cent or more of the tal farm acreage in the South is clas- fied as woodlands, and these lands pre- nt an opportunity for developing and aying an important role in the farm onomy. During the past few years of pression, farmers in many portions of e South have been living on the income ey have derived from the sale of rest products from their farm wood- nds. With more attention paid to the ndling of these farm woods the present come might be appreciably increased. t is interesting to note," said Mr. Grae- r, "that the agricultural workers in the other lines of agricultural work are just beginning to take an interest in the farm forestry program."

T. L. Ayers, Principal Agricultural Economist of the Southern Division of the A.A.A. spoke on the "Agricultural Conservation Program in Relation to the Forest Crop on the Farm." In his address Mr. Ayers stressed the important role which forestry should play in the conservation program. Following his address there was considerable discussion which brought out some of the recent developments and ideas regarding the provisions which have been written into the program for the southern states.

Earl W. Tinker, Assistant Chief of the U. S. Forest Service, in charge of State and Private Forestry work, presented the Forest Service point of view on forest land use. In Mr. Tinker's opinion, the real problem which is facing the South, as well as other parts of the country, is the proper management of the privately owned forest lands. He stated that the Forest Service favors a program of plenty instead of a program of scarcity. The specified policies regarding the action which must be taken must of necessity be decided in every state before steps can be taken to bring about the desired results. The old policy of disposing of public lands followed by exploitation must now be superseded by one of conservation, proper land use, and forest management. Mr. Tinker stated that the problems which now confront us might be treated under three separate heads:

1. How the existing old growth can be handled economically.

2. With ⅓ of the forest area classed as cut-over land, the proper use of this large area presents a major problem.

3. With more than 50 per cent of the farm area in the South classed as forest land, its proper management also constitutes a major problem.

With only one extension forester in each

state, the present personnel is entirely inadequate to handle the farm forestry problems. Mr. Tinker further discussed the need of an intensive campaign to educate the farmers in better methods of handling their farm woodlands.

Julian F. McGowin, of the W. T. Smith Lumber Company at Chapman, Ala., presented one of the outstanding papers of the entire forestry session. The subject of his paper was "The Lumberman's Viewpoint on the Forestry Program for the South." In his paper, Mr. McGowin mentioned that the recent trends indicated that more and more sawmill operations were being carried on on a selective logging basis with sustained yield as their ultimate objective. In 1935 six sawmills in the South were certified by the Lumber Code Authority as growing more timber than they were cutting. In addition, 137 operators were listed as conserving growth or making provisions for keeping their land productive. With 90 per cent of the forest land area in the South in private ownership, the success or failure of forestry in this region depends on the action taken by private owners. It is Mr. McGowin's belief that the major problem confronting the owners of timberland in the Southern Region is the constant threat of losing the major portion of their investment through forest fires. He stated that the three conditions necessary for future development of our southern forests were:

1. Fire protection.
2. Fair taxation.
3. Some security for forest ownership.

Dr. Clarence F. Korstian, recently elected President of the Society of American Foresters, was a principal speaker at the banquet held on Wednesday evening. Dr. Korstian spoke on some of the problems confronting the Society and some of the policies which he aimed to carry out during his 2-year term. Representatives of the five southern Sections of the Society were introduced by Mr. Graebe who acted as toastmaster. The dinne was followed by a dance, and was con sidered one of the high lights of th meeting.

The meeting Thursday morning wa devoted to a discussion of variou phases of the pulp and paper industry i the South. The Honorable Harry L Brown, Assistant Secretary of Agricultur opened the morning meeting with a di cussion of some of the farm and fore problems in the southern states, and fo lowed this by reading a paper entitle "The Place of Timber Farming in Moder Agriculture." The Assistant Secretary talk was one of the drawing cards of th morning session.

Matt Rue, of the Brunswick Peninsu Company at Brunswick, Ga., presented most interesting paper on "The Pulp an Paper Industry in Relation to Fore Farming in the South." Because of illnes Mr. Rue's paper was read by Ka Swenning of the Mead Corporation. T paper stressed the fact that the increa in the number of pulp and paper mil in the South would furnish a market f a low grade product which the lan owners previously had been unable sell. The Brunswick Peninsula Co pany furnishes wood to the Brunswi Pulp and Paper Company. Their a proach to the problem of wood procu ment is to bring proper cutting practi into the woods, and to encourage t small woodland owner, as well as larger owners, to cut their timber on selective basis so that repeated crops m be cut. The Brunswick Peninsula C pany has a corps of foresters to head its wood procurement work. As an ad incentive to proper cutting, the comp plans to pay a bonus to landowners w cut their timber according to the c pany's recommendations.

Oscar Steanson, Bureau of Agricult Economics, spoke on the subject of "

ting Timber Farming Into the Farm Management Program." His paper stressed the fact that the farmer might readily increase his farm income through the proper management of his farm woods, and that he could also obtain from these farm woods his fuelwood, his fence posts, and other forest products needed on the farm.

C. E. Curran, principal chemist in charge of the Section of Pulp and Paper of the Forest Products Laboratory, Madison, Wisc., presented a very interesting explanation of the effects of forest growing conditions on the suitability of southern pine for the manufacture of pulp and paper. Mr. Curran stressed particularly the fact that the manufacture of kraft pulp and paper by the sulphate process was best suited to utilize pulpwood cut from the southern pine forests. Owing to the presence of heartwood and resin, it was impossible to economically manufacture sulphite pulp or paper or newsprint. Unless the southern pine pulpwood can be restricted to the resin free sapwood, it is doubted whether the present sulphate mills will be supplanted by ones manufacturing white paper.

A general discussion on the subject of 'How Can Pulp Mills Be Guaranteed a Permanent Supply of Timber" was directed by G. H. Lentz of the U. S. Forest Service of Atlanta. It was generally agreed that the most effective means to achieve this objective was through better fire control, and that until the fire problem was solved it would be impossible to bring about the necessary forest management needed to secure maximum yields of forest products. Another subject which was widely discussed was whether publicly employed foresters should discuss timber values and prices in meetings and with timber owners.

Resolutions favoring increased Clarke-McNary funds, the strengthening of the forestry extension program, and the continuation of the Forest Survey were adopted by the Forestry Section.

J. Brooks Toler, Extension Forester for Mississippi, was elected chairman for the ensuing year. H. A. Smith, State Forester of South Carolina, was elected vice-chairman, and W. R. Hine, of the U. S. Forest Service, was elected secretary and treasurer.

The following resolution was adopted by the Association:

Whereas, farm woodlands in the South form a large percentage of the total land area owned by farmers, and

Whereas, these lands have potentialities under proper management for greatly expanded timber production which will contribute substantially to the cash income of farmers, to industrial development, and to the general prosperity of the South, and

Whereas, the proper use and management of these farm timber resources are intimately associated with the development of a permanent and sound economic program for agriculture.

Therefore Be It Resolved that the state and regional offices of the Agricultural Adjustment Administration be urged to give more consideration to the need for better forest practices and to include such provisions in the agricultural conservation program as will encourage widespread adoption of such practices, and

Be It Resolved Further that greatly increased federal and state appropriations be made for cooperative fire protection, forestry extension, and for the production of forest tree seedlings under the provisions of the Clarke-McNary law and the Norris-Doxey law, and that funds be made available for the completion of the Forest Survey at the earliest possible date.

G. H. Lentz,
Past Secretary, Forestry Section.

Resolutions Adopted by Western Forestry and Conservation Association, Portland, Oregon, December 8-10, 1937

1. We favor a present federal legislative program of only immediately essential subjects and recommend as such:

A. Increase in authorization and appropriation for forest protection under Clarke-McNary law and to immediately appropriate the maximum of present authorization.

B. Adequate support for Forest Products Laboratory.

C. An amended McNary-Doxey bill.

D. At least two million dollars for carrying out the Fulmer Act.

E. Provision for insect and disease control on public and private lands, research and inauguration of a definite long time program of control and research.

F. The Forest Survey: The survey of forest resources, authorized by the McSweeney-McNary Act in 1928, which has been very useful for many purposes in those states which have been so far covered, yet it has not been completed in most of the western states. Appropriations should be provided by Congress for the speedy completion of this project and for keeping the original survey data up to date.

2. We recommend the amendment of Clarke-McNary Law to the extent that principles of allotment be made statutory and be based on performance and expenditure, and that federal allotments be increased to 50 per cent of total cost of adequate performance.

3. We deplore the present Forest Service policy of requiring private timber owners to adopt specific forest practices on their holdings in order to obtain timber under a government sale.

4. We feel that all governmental agencies issuing publicity matter relating to forest use should studiously avoid unfair and unjustified reflections on industry practices until experiment and experience indicate that certain practices may b[e] improved or abandoned.

5. We commend a policy of period[ic]ical local meetings of federal, state, an[d] industry representatives to discuss an[d] perfect plans for public acquisition, betterment of forest practices, public timbe[r] sale policies, publicity programs, and related subjects to the end that there ma[y] be complete understanding between th[e] agencies regarding forest policies an[d] practices in each region.

6. We commend the research bein[g] conducted by the forest experiment sta[-]tions and the Forest Products Laboratory and believe that it is materially promotin[g] better forest management and utilizatio[n] on both public and private lands.

7. We express appreciation to the U. S. Weather Bureau for their increasingl[y] valuable service in furnishing forecast[s] of dangerous fire weather and urge prope[r] support for this work. We further appre[-]ciate the cooperation of radio broadcasting stations in disseminating this impor[-]tant information.

8. We express appreciation to th[e] public agencies and the Pack Foundatio[n] which participated in the 1937 meetin[g] of Western Forestry and Conservation As[-]sociation and brought to this gatherin[g] information of present day and propose[d] public policies.

9. We pledge, in so far as practica[l] full private and state cooperation in a[ll] forest policy matters previously enun[-]ciated.

Charcoal from Forest Waste for U[se] in Camp Fireplaces

A somewhat casual fuel survey ma[de] recently in the state and national par[ks] in Region Three (Southwestern) of t[he] National Park Service revealed a serio[us] scarcity of fuel for camp use in are[as] such as White Sands National Monume[nt]

New Mexico, visited annually by a large number of people, and in a number of the other monuments and state parks in the Southwest. This same survey also showed that in several timbered areas where lake site clearing was in progress in state parks and other development work was under way, both in state and national parks, an abundance of material suitable for making charcoal was being burned to dispose of it and to make way for equipment used in development work. Another source of material is the many trees and branches damaged beyond natural recovery or repair in the areas visited by sleet storms last winter.

It is believed that if this material, which must be removed, could be preserved in the form of charcoal it would alleviate the fuel situation in Region Three for a considerate period of time. The preparation and use of this material for fuel, and also of placing it in dry storage where it will not be subjected to destruction by fungi, insects, or fire, constitute an important park development problem.

Logs and larger branches suitable for fuel are placed in fuel yards with provision for protection, but this arrangement has not provided for use or storage of branches, slash, and small trees which, during clearing operations, are usually burned on the job to clean up the area.

We propose to convert this waste material into charcoal to be used as a fuel in fire places and grills in the camp grounds of our parks, particularly in those areas where fuel is scarce.

It is believed that charcoal can be made very economically and that, being light in weight, its distribution to parks having little or no available fuel can be handled by shipment in burlap bags.

Our experience has shown that if charcoal is to be advantageously used in the park fireplaces the present type of fireplace will have to be remodeled or a specially constructed charcoal burner provided, as those now in use are much larger than needed for charcoal. Furthermore, it is necessary to provide for natural draft through the bottom of the burner. Charcoal burns without smoke or sparks and for that reason it is believed to be much safer than wood as a camp fuel. It may even be found to be more economcial.

TABLE 1

Factors considered	Green gum	Green pine	Dry pine	Green white oak
1. No. cu. ft. wood	17	28	28	24
2. Wt. of wood	650	860	610	663
3. Cu. ft. charcoal	9	15	16	12
4. Wt. of charcoal	99	116	120	146
5. Percentage loss by volume	47	46	43	50
6. Percentage loss by weight	84	86	80	78
7. Average diam, of material	2"	2"	3"	3"
8. Hours heat applied	6½	8	2½	5
9. Hours cooling	10	10	10	10
10. Labor (MD) required to charge, burn, and discharge	2	2	2	2
11. Gal. fuel oil used	35	40	18	20
12. Gal. gas used in compressor	6½	8	3½	6½
13. Qts. oil used in compressor	1	1	1	1
14. Remarks:				

Total production 68 cu. ft.
602 lbs.

Cost $2.52 gasoline
3.93 fuel oil

Total cost $6.45

Photos by National Park Service

Fig. 1.—Methods of charcoal production and use

A Arrangement of faggots to form "beehive" dirt pit. Note lighter tube in foreground
D Yield of charcoal in "boiler section kiln"
E [illegible]

The experimental work on charcoal making has been done at the Daingerfield, Texas, State Park Camp by T. L. Edwards, C. S. Winsborough, and others in the camp who have become interested. Practically every phase of charcoal making has been tried. Individual ingenuity and desire to produce a satisfactory product prompted them to explore fully the field of charcoal production.

ig. 2.—Upper photograph shows a fire started n a beehive dirt pit. The fire is allowed to urn from 1½ to 3 hours before the vents are ealed. Lower photograph shows the construction of a boiler section kiln.

The first experiments dealt with the pit method of charcoal making. This method resulted in low material and labor cost. However, it was thought that the volume of charcoal could be increased and the quality improved. It was also found that the composition of the earth used to make the cover over the wood greatly affects the efficiency of the firing and also the quantity and quality of charcoal produced. A sandy soil, unless mixed with a high percentage of clay or adobe, will not bake, and, therefore, will cave in, and by admitting air result in rapid and complete combustion. On the other hand, clay or adobe soils were found to pack, dry out, and remain solid over the wood and, if properly constructed, only an occasional plastering of cracks will be necessary. Removing the charcoal from the pit and sifting the dirt from it is a rather important procedure, as charcoal should be free from foreign substances and not too finely broken.

The retort method was next tried. The retort was made from shells of old horizontal boilers. Considerable work was necessary to cut, shape, and weld the parts together. Since waste crankcase oil was to be used for fuel to heat the wood in the retort, it was necessary to provide storage and to pipe it to the fire box. An air-compressor was necessary to provide a forced draft and to atomize the waste oil into an efficient and controllable form of fuel.

The woods used in these experiments were dry pine, green pine, green gum, and green white oak. Table 1 taken from a report submitted by C. S. Winsborough shows the results obtained.

It is apparent that the fuel cost of charcoal made by the retort method in

this experiment is a trifle over one cent per pound.

The following comments in connection with this experiment are of interest since a partial analysis of the operation was made.

No temperatures were recorded because thermometers were not available. The amount of heat applied might have been reduced if temperatures and rate of reaction within the retort could have been known.

No use, accurate measurement, or analysis was made of the distillate, but it was condensed in a bucket which served as a trap, allowing vapor to escape but permitting no air to enter the retort. The yield of distillate was not considered important because charcoal is the product desired, and utilization of the distillate probably would be difficult.

No record is available of the minimum time required to cool the charcoal before the retort could be opened, other than the experience gained by opening the retort too soon on one or two occasions. No attempt was made to remove the retort from the hot fire box and cool it by a spray of water, air, or live steam because the necessary equipment was not available. If the temperatures had been recorded and if the retort could have been removed and cooled, discharged, charged again and replaced on the hot fire box, considerable time might have been saved and the fuel cost might have been reduced materially.

A retort for the production of charcoal in quantity should be much longer than the experimental retort and should be provided with a quick sealing, air tight door large enough to facilitate charging and discharging.

The experimental retort was semi-portable although, at the time of the construction, mobility was not taken into consideration. The fire box, made of brick and mud, can be dismantled and easily moved to a new location. The shell or steel retort could, it is believed, be moved on a trailer behind a truck which hauls the fire brick, the small air compressor, winch for handling the retort, compressor, and fuel barrel. After the plant is set up, the truck could be used for hauling fuel from the forest to the retort.

W. H. Wirt,
National Park Service.

Proper Utilization of Bunchgrass Range

There are in portions of the Kaibab and Coconino National Forests in northern Arizona about half a million acres of coarse bunchgrass timber range characterized by a predominance of Arizona fescue (*Festuca arizonica*) and mountain muhly (*Muhlenbergia montana*) with an overstory of ponderosa pine. Severe browsing damage to pine reproduction has occurred over the range in the past and this has focused attention on the range management problems of the type. Tentative standards of forage utilization have been formulated to guide in the proper use of the range.

Indicator Species

Arizona fescue and mountain muhly are the two species on which the utilization standards are based. These two grasses aggregate between 60 and 90 per cent of the forage and usually total about 85 per cent. Grasses as a whole comprise from 85 to 95 per cent of the total forage, while weeds constitute most of the remainder.

Time to Apply Standards

There are two critical periods during the usual 5-month grazing season from June through October. A separate set of standards has been developed for each of these periods. One set applies to the end of the grazing season, which in this type is nearly coincident with the end of the

growing season. These fall standards may be applied any time during October. The second set applies to the end of the summer dry season, which is roughly coincident with the end of the period of highest fire hazard. These summer standards may be applied July 1-15.

CLASS OF STOCK

The standards are applicable to any class of stock; provided that the first standard to be reached shall be the limiting one. For example, if muhly is found to be grazed up to the limit set by the standard, use of the range should be considered proper at that point even though fescue may be underutilized according to its standard. There should not be further grazing to obtain more use of the fescue, for in so doing muhly will be utilized beyond its standard limit and the range as a whole will then be overgrazed.

YARDSTICKS OF PROPER USE—OCTOBER STANDARDS[1]

1. Leave 55 per cent of the available forage volume[2] on the ground. Choice feed and small grass tufts cropped closely. Some large bunchgrasses taken 40 to 60 per cent.
2. Arizona fescue: 35-40 per cent of the volume eaten; 60-65 per cent left on the ground.
3. Mountain muhly: 45 per cent of the volume eaten; 55 per cent left on the ground.
4. Leave about 25 per cent of the flower stalks evenly distributed over the area.
5. Do not let the average height (excluding flower stalks) of either fescue or muhly drop below 6 and 4 inches, respectively. The mean height of ungrazed fescue leaves varies from year to year from 9 to 12 inches and averages about 10½ inches.
6. Density of fescue and muhly should be constant or increasing; whereas density of blue grama should be constant or decreasing.
7. A typical range of 24,000 acres in this type had an average density of .35, a type palatability of 46 per cent, and a forage-acre factor of 16.1. Proper use was attained on this range by stocking to 4.8 surface acres per cow per month. The forage acre requirement on the basis of known stocking and the forage-acre factor was computed to be 9.3.

YARDSTICKS OF PROPER USE—JULY STANDARDS[1]

1. During the summer dry season, use should be ⅓ as heavy as proper use during the balance of the grazing season as defined under the October standards. This may be attained by reduced stocking, shortened season, or various combinations of the two, and may be measured by the following standards:
2. Leave 85 per cent of the then available forage on the ground. Succulent portions of the palatable plants taken. Light cropping of plants making up bulk of the usable forage. Large coarse bunchgrass tufts scarcely eaten; utilization confined principally to smaller tufts of bunchgrasses and weeds.
3. Arizona fescue: 15 per cent of the volume eaten; 85 per cent left on the ground.
4. Mountain muhly: 10-15 per cent of the volume eaten; 85-90 per cent left on the ground.

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[1]These standards are wholly tentative and preliminary in nature. They are founded on the best available but entirely insufficient data and are thought to apply only to the coarse bunchgrass type in question. The standards consider damage to pine reproduction and properly applied should result in reasonable control of damage.

[2]Percentage volumes of forage are based on ocular estimates.

5. Average height of fescue (excluding flower stalks) should be not more than 1 to 1½ inches below the average of ungrazed plants which varies from year to year from 6½ to 11½ inches.

EDWARD C. CRAFTS,
Southwestern Forest and Range Experiment Station.

Seed Origin Affects Survival of Green Ash in the Nursery[1]

In connection with the large-scale reforestation activities now under way in this country, it has been frequent if not common practice to obtain seed for nursery stock from whatever source was possible, even though that source might be a great distance removed from the area to be planted. Cheapness rather than quality has been the guide usually followed.

The fallacy of using such seed is well illustrated by results obtained with green ash seedlings from different sources planted at the Station's North Dakota branch at Denbigh. In the spring of 1935, 69 small lots of seed, collected in various states of the prairie plains region in the fall of 1934, were sown in the experimental nursery. Survival counts were made in September 1935 and again in July 1936. The latter are presented in the following table:

State	Number of lots of seed	Total number of trees	Average weighted survival per cent
North Dakota	25	294	67
South Dakota	12	532	62
Nebraska	21	913	48
Kansas	8	243	43
Oklahoma	3	132	7

As will be observed an almost regular reduction in survival was shown by the seed progressing from north to south. Most of this loss was due to the inability of the seedlings from southern seed to withstand the winter of 1935-36 at Denbigh. This occurred in spite of a fairly good snow cover on the seed beds over much of the winter. A portion of the loss was, of course, caused by drought, but since all the trees were occasionally watered, this was of little importance.

As the trees become taller and get above the general snow level, it is probable that the seedlings of southern origin will continue to suffer losses. It is therefore apparent that seedlings of local origin even in the early stages of development have a considerable advantage over seedlings from other sources; at least, moving seed for long distances is apt to be dangerous.

Storage of Plant Food Affected by Grazing Scientist Reports

One of the keys that will help to solve the perplexing range problem of plant recession and decrease of plant vigor on grazed areas of the west, may have been uncovered in a recent study made by the late Dr. Edward C. McCarty in cooperation with the Intermountain Forest and Range Experiment Station.

Many-flowered bromegrass, one of the most important native forage grasses, was selected by Dr. McCarty to use in studying the growth and carbohydrate behavior of the plant throughout the periods of rest and active growth. He began sampling at snow recession in 1932 and finished at snow recession in 1935, covering a period of 38 months of continuous observation at the Great Basin Branch Station near Ephraim, Utah.

The experiment was conducted within an enclosure which had been seeded to native grasses in the spring of 1925, r

[1]Technical Note 128. Lake States Forest Experiment Station. Maintained by the U. S. Department of Agriculture in cooperation with the University of Minnesota.

sulting in an excellent stand of many-flowered brome. The immediate area from which the food march samples were collected was approximately 75 feet by 100 feet, and the plots were either clipped or left untouched to simulate grazing or restriction of grazing.

Dr. McCarty found that the annual growth of the herbage begins some 45 to 89 days prior to snow recession, and that the carbohydrate accumulation occurs during the declining phase of current seasonal shoot growth, the upturn usually comes at the same time as blooming. He further observed that the storage process ceases during secondary shoot growth but is renewed upon the conclusion of this activity in the plant. The herbage may remain green, however, until the first permanent snowfall in the autumn, and approximately one-third of the total sugar and starch stores is laid down following seed maturity. This fact clearly emphasizes the need for some protection to range plants during the autumn season.

In his analyses of hundreds of plants during the 38-month study period Dr. McCarty found that large stores of starch and sugar are used by the plants during the so-called rest period over winter, prior to the initial growth of the herbage in the spring. "This shows that the maximum stores of the sugar and starch materials are essential to winter survival, and the production of vigorous shoots following snow recession in the spring", he wrote following the study.

This study further explains why the season and the frequency of clipping greatly affect the carbohydrate metabolism of important summer range plants. The time of food storage by plants should, therefore, be considered in a program for preventing injury to plants through overgrazing or unmanaged use of the range which might bring about loss of plant vitality and vigor or the loss of the plant itself.

Fundamentals in Artificial Revegetation of Semidesert Areas

Agencies interested in the maintenance of productive ranges have recognized the need for artificial revegetation where soil and climatic conditions are so adverse as to make natural revegetation slow or impossible. These agencies have responded to this need by making numerous plantings on a scale greatly exceeding any previous endeavors.

Widely different results have been obtained. In general, the successful plantings were preceded by investigations which furnished information pertaining to the requirements of the plants used. The urgency for providing work for many unemployed laborers and for the immediate treatment of rapidly deteriorating lands resulted in much hit-and-miss planting, which is perhaps responsible for most of the negative results. Some lessons have been learned from these endeavors, however, that may well be applied in future plantings, but the need for more knowledge of fundamental facts on plant requirements is keenly felt.

In revegetation work on deteriorated sandy lands of the Jornada Experimental Range, near Las Cruces, N. Mex., an order of procedure has been worked out step by step that seems to give promise of successful results in revegetation efforts.

1. First, obtain a general picture of the vegetation, soil conditions, and climate of the area considered through general vegetation and soil surveys and available climatic records.

2. Study the results of past investigation on similar lands, if there are any such results.

3. If an area is deteriorated, ascertain the principal factors that caused the break-down, and which of these factors may be wholly or partly controlled, as grazing, rodents, and accelerated water and wind erosion.

4. Determine the kinds of plants adapted to the area and most suitable for the purposes intended. In general there are four sources of seeds of such plants:

a. Plants that were once dominant and which may be found on nearby undeteriorated lands.

b. The most suitable plants still remaining on the area or areas considered.

c. Plants that do not occur and probably never grew on the area, but which thrive on similar areas in the region.

d. Available exotic, or introduced, plants which seem adaptable to the area or areas considered.

5. Test the seeds of each of the chosen plants; and in small-scale experiments, ascertain the conditions for optimum germination under field conditions, as well as the requirements for best growth:

a. Germination tests to determine if after-ripening process is necessary, percentage of germination under laboratory conditions, and for those seeds that give low germination due to hard seed coats, test to ascertain how best to scarify the seeds.

b. Field germination tests in enclosed seedbeds, in order to determine the proper depth of planting, the proper season for planting, soil conditions best suited for the plants, and whether shading or protection of some sort is necessary for germination and early growth.

c. Small-scale field tests to ascertain the best method to sow and cover the seed, and the quantity of seed required per acre. If field tests show that seeds germinate only in certain spots, analyze the field conditions for causes of failure. Seedlings may occur naturally on the area. If so, determine under what conditions they grow and how such conditions may be created on the area considered, or in spots.

d. From the data that may be accumulated from such a series of tests, definite procedure may be outlined for attacking the problem of revegetation of a given area. The chances are that the plants of some species will have to be eliminated, because of their total failures. Perhaps one or two kinds will stand out as most successful, and hence would be desirable from the soil conservation point of view.

Fortunately, these various steps can be followed concurrently.

John T. Cassady,
Southwestern Forest and Range Experiment Station.

A Field Photographic Scale

Most forestry photographs give too little attention to scale. Many photos show no scale at all, or if some alleged concession to accuracy is made, the scale employed is likely to be either of those old favorites—John Doe's hat, or his jackknife. In an attempt to improve this undesirable situation, there is used at the Dunbar Forest Experiment Station a field photographic scale which may be used in almost any type of picture. The scale was made from a one-inch pine board five feet long and four inches wide. In use, the board is maintained in an upright position by means of a spike attached to the bottom. Either strap or round iron will serve for this purpose. The spike should be about ten inches long with one end sharpened, and the other drilled for two screws by which it is attached to the board. The scale is painted white with one-inch black bands marking the foot intervals. At the top of the board are driven small brads in a vertical row two inches apart. Upon them are hung two-inch squares of light sheet iron, painted white and bearing stenciled numbers. Thus, any photo may be identified so as to distinguish it from others in the same roll of film; sample plots may be recorded by their file number; and the date may be included in any

picture. For close work the one foot division was found to give a satisfactory comparison without further subdivision. If fine measurement is required, a pocket rule may be set up against the scale. For distant views the entire scale is sufficiently large to be acceptable. As a convenience in carrying, a common barn door handle was screwed to the back of the board.

W. F. McCulloch,
Oregon State College.

Extensions in the Range of Lake States Trees[1]

Knowledge of the general distribution of forest trees is basic to the successful handling and propagation of forests. Due, however, to the relatively short time that this country has been settled, the ranges of many of our native American trees are imperfectly known. The federal Forest Service is therefore constantly collecting data on the occurrence of different species and presenting this information in the form of range maps.

During the past few years members of the staff of this Station, particularly Messrs. Kittredge and Roe, have extended our knowledge in the distribution of our Lake States trees. The most important of these are given in the following table:

Especially notable is the extension of the range of hemlock to the eastern side of Mille Lacs in central Minnesota, the westernmost station known for this species in North America. Although in former years hemlock was found at several scattered locations in Pine, Carlton, and St. Louis counties, the great fires of 1918 destroyed all traces of these trees, and until recently this graceful evergreen

Species	Locality	Previously known extreme range in that locality[1]	New occurrences	Extension in range Distance	Extension in range Direction
				Miles	
Silver maple	Upper Peninsula Mich.	Southern Wis.	Mouth of Ontonagon R.	250	north
	Northern Minn.	Southern Minn.	Lower Red L.	250	north
Rock elm	Northern Minn.	Northern Iowa	Northern Itasca co.	300	north
	Northeastern Wis.	East-central Wis.	Wausaukee Marinette co.	300	north
Jack oak	Northwestern Minn.	Southern Cass co.	Lower Red L.	100	northwest
	Northeastern Minn.	Carlton co.	Tower, St. Louis co.	120	northeast
	Upper Peninsula Mich.	Northern Wis.	Trout Creek, Ontonagon co.	50	north
White oak	Northeastern Wis.	North-central Wis.	Dunbar Twp., Marinette co.	50	north
Red oak	Northeastern Minn.	East-central Minn.	Cramer, Lake co.	50	northeast

[1]As given in Sudworth's "Check list of the forest types of the United States, their names and ranges."

[1]Technical Note 129. Lake States Forest Experiment Station. Maintained by the U. S. Department of Agriculture in cooperation with the University of Minnesota.

was believed lost to the state. Other areas where hemlock occurs have since been found east of the Mille Lacs trees so the tree is probably not as near to extinction as had been thought.

Reseeding Trials Show Best Species for Oakbrush Range

Artificial reseeding trials made by the Great Basin Branch of the Intermountain Forest and Range Experiment Station in Ephraim Canyon during the period 1928 to 1935, show the following grass species suitable for reseeding oakbrush ranges: common brome, mountain brome, crested wheatgrass, and slender wheatgrass.

Common brome was found to be especially suitable. This species produced excellent foliage and matured an abundant supply of viable seed on each of the three study areas. It also has the added advantage for reseeding grazed areas because it reproduces by vegetative propagation as well as by seed.

The best stands of mountain brome were obtained at the upper limits of the oakbrush range, or 8,000 feet above sea level where about 20 inches of precipitation falls annually. However, good stands resulted throughout the zone.

In the case of the crested wheatgrass, good stands were obtained on the oakbrush range up to elevations of approximately 8,000 feet; while the slender wheatgrass produced best at the middle oakbrush area at about 7,890 feet elevation and increased naturally on all experimental areas.

Tests made with yellow and white sweetclover showed these species to be unsuited to the oakbrush ranges.

On the summer ranges of higher altitude common brome and slender wheatgrass particularly have shown promise for reseeding purposes.

While good results were obtained from both spring and fall sowings, when the precipitation after planting was normal, the fall sowings proved to be more reliable.

The best stands were observed on areas where the soil had been plowed in furrows three feet apart, the seed sown by hand and covered by dragging. This method cost $6 per acre. However, fair stands were obtained by sowing the seed broadcast with no further treatment. This method cost 65 cents per acre.

The range carrying capacity of experimental reseeded areas comprising 64 acres in sagebrush types was increased from 222 to 719 per cent depending on the species used.

REVIEWS

Personnel Administration in the Federal Government. By Lewis Meriam. *62 pp. The Brookings Institution, Washington, D. C. 1937. Price 50 cents.*

This scholarly treatise is worth the attention of every forester and public employee. It goes to the root of the problems of government as affected by the character of public service. Space is too limited to review the pamphlet in detail. It deals with elements of the personnel problem, the elimination of spoils, personnel work under management, control over personnel functions, promotions, education, the merit system, the Civil Service administration, and discusses in detail the proposed reorganization plan. Under "Recommendations" is given:

"In so far as the Constitution will permit, recognize the permanent administrative structure of the national government as the people's service and not the service of the party in power at the moment. That means that the structure and its permanent staff belong not to any party but to the country as a whole. The President and the Congress occupy the structure and direct the servants but they do not own it; and as tenants they are not to destroy its efficiency by dismissing trained, experienced, competent servants to make room for political employees. Such a conception is the strength of the British system. There the administrative branch is not the service of the ministry of the day but the service of the Crown. The ministry of the day can change only a few of the directing officers. Until this conception is applied to its logical limits, it is idle to talk of career services, because selection by merit and permanence of tenure, so long as efficiency is maintained, are the minimum essentials for a genuine career service."

The conclusion is stated as follows:

"Believers in concentration of power in the executive will say that these recommendations savor of the old system of checks and balances. The American Constitution is based on checks and balances; and so long as the fundamental law is thus designed, the administrative structure should be in harmony with it and not contradictory to it."

H. H. Chapman,
Yale School of Forestry.

This is Our World. By Paul B. Sears. *292 pp. Illus. University of Oklahoma Press, Norman, Oklahoma. 1937. Price $2.50.*

It has been stated that foresters are equipped, through training, to assume leadership in the solution of the nation's land-use problems, but land-use problems cannot be considered by themselves. They are an interdependent part of the social, economic, and political problems which make up the big problem of securing a balance in men's relationship with one another and with nature. In short, we need leaders who not only know forestry, who not only are acquainted with land-use problems, but who also have the ability to visualize the place of these problems and their solutions in the entire social picture.

Unfortunately, our American system of education is not designed to develop

a nation of thinkers. Even the college student, including the forestry student, is not aided greatly in obtaining that understanding of the relationships existing between the various natural and social sciences.

Paul Sears is an eminent scientist who has not only acquired a broad understanding of the relationships between these natural and social sciences, but who possesses the ability to portray these relationships in writing. He possesses a gift of epigram which can in a few words crystallize a whole concept. Add to this a pungent humor and you have not only instructive reading, but highly interesting as well.

A few extracts from *This Is Our World* are quoted:

"Certainly there are two sides to man's place in nature. He himself is unquestionably a work of relative perfection. But so is the world into which he fits. The two have grown up side by side. And the modernized earth is far more essential to man than he is to it. Earth has calmly witnessed the passing of many very interesting kinds of life when they ceased to be fitted to her conditions. Certainly man should be somewhat cautious in dismantling an abode so admirably fitted to him, for in the very nature of things he is not the one to have the last word.

"But the trouble is that we have not so much listened to the scientist, as taken him in hand. We have used him, not as a consultant, and friend, but as a handy man. He has been kept in the workshop as a trouble-shooter, not invited to sit with the board of directors. In fact, he has seldom been groomed for the latter and greater task. In his training, instead of being allowed the Grand Tour through the realms of the mind, he has been caught young and subjected to an intensely narrow and specialized apprenticeship. This has made him tremendously efficient within a narrow range, but has clouded his vision, his sympathy, and his knowledge of his own responsibilities.

"But modern civilization, more than any which has gone before, is living visibly and dangerously beyond its means. The power and knowledge at our disposal are being used as never before, to drain the treasures of the past and borrow from the future. We are flowering for the sake of the immediate present, and at an accelerated speed. When pressed about the outcome, we merely shrug our shoulders and say 'Science will find a way.' So rapid is the change, and so dazzling each passing moment, that it has come to seem as though the present were all-sufficient. The past, so dark, dim, and different can be forgotten; the future will take care of itself. Continuity and destiny can be left for the curious and idle. The busy world of affairs has neither need nor time to think of them. The Three Fates have been banished with all the other junk of our ignorant and fumbling fathers.

"For the first time in its geological history, earth is overrun and ruled, not by a group of organisms, but by a single species. Will this species avoid the fate of the mighty groups which preceded it?

". . . . .modern man has lost his fear of and immediate, responsible contact with nature. Yet we must remember that he still works within the frame of natural cause and effect. He is as responsible to nature as he ever was. Moreover his scientific approach has created a mechanism of living which is, in itself, a source of new problems. Yet it has given him also the means of understanding. He need not, indeed, dare not, avoid the problem of a wise use and coordination of the forces he has invoked."

The illustrations consist of simple, often humorous, pencil drawings by the author. Each drawing adds emphasis

to or further crystallizes some thought developed in the text.

Foresters, especially the younger foresters, will find *This Is Our World* well worth reading.

L. B. Ritter,
Bureau of Entomology and Plant Quarantine.

Holz als Roh- und Werkstoff. Jahrgang 1, Heft ½. October-November, 1937. *Published by Julius Springer, Berlin. Price, RM 6 per quarter or RM 2.50 per copy.*

This is a new journal in the field of forest products research and utilization. It covers all aspects of mechanical and chemical properties and uses of wood and timber by-products. Its scope is indicated by the following partial list of contents of the first number:

Wood as a Raw Material in World Economy.

The Use of Stem Analysis in Investigating Properties of Wood.

Properties and Uses of Artificial Resin Glues.

The Present Status of Wood Sugar Production.

Investigation of the Properties of Moth-killed Spruce Timber.

Production of Beech Cellulose by the Alkali Process.

A valuable feature is the review of current literature dealing with forest products. The current issue contains abstracts of 200 papers in various languages.

The Editor-in-Chief of the new journal is Dr. F. Kollmann, of the Prussian Timber Research Institute at Eberswalde, whose manual "Technologie des Holzes" was reviewed in a recent number of the Journal of Forestry. Associated with him are numerous workers in forest products research in Germany, Austria, Czechoslovakia, Switzerland, Finland, Sweden, Denmark, France and Yugoslavia.

The Beech in Denmark. (Parts I, II, and III.) By L. A. Hauch. Translated by Miss Betsy Neergaard, Brondsted. *73 pp. Illus. Gyldendal, Copenhagen, 1937.*

This is the last book by a forester who devoted his entire and unusually long life to forestry for the sake of the forest.

L. A. Hauch died in January, 1938, at the age of 92, a few months after he had completed *The Beech in Denmark.* He was manager of large private forests until 1915, when he retired, but before this time and later he was a prolific writer. Together with A. Oppermann, he published a large manual of forestry and wrote numerous articles on silviculture (see: Bibliographia Universalis Silviculturae I Dania). His last three publications were written in English.

Hauch saw the great variations between species in form and growth habit and he called this "deviation capacity" (Spredningsevne), a term now internationally used. He emphasized the need for a great number of plants in the reproduction of species with strong deviation capacity such as oak, beech, and Scots pine, while species of weak deviation capacity such as spruce should have a smaller number.

Hauch was an ardent enemy of the "continuous forest" idea (Dauerwald) as this was experimented with in Denmark. He advocated, as almost all leading foresters in Europe do today, that most species should be reproduced both naturally and artificially under a shelter, but he warned against the irregular, too open condition frequently with sparse reproduction and soil deterioration which

the continuous forest often created. He advocated "the closed forest" as he called it, starting with a first-class reproduction, disregarding all costs, which to him were of minor importance. This reproduction should be started under shelter and thinned continuously during the rotation, working for the best individuals and leaving an understory for protection of the site. This is stressed in *The Beech in Denmark* as well as in its predecessor *The Oak in Denmark*.

Hauch's influence on forestry in northern Europe was great during the latter part of the former and the beginning of this century, but he worked for the sake of the forest only and the younger generations could not follow many of his theories when the economic and the social importance of the forest came into the foreground of forestry.

Unfortunately, the English in his book is poor and his technical terms are in many cases difficult to comprehend.

Svend O. Heiberg,
New York State College of Forestry.

The Motor Truck in Woods Operations. By C. R. Townsend. 80 pp. *Illus. Woodlands Section, Canadian Pulp and Paper Association, Montreal, 1937. Price $2.50.*

Motor trucks have assumed a permanent place in recent years in the transportation of forest products from the skidway to the mill or to some transfer point on a railroad or stream. Although they have been used by loggers for the last 25 years, the modern methods of truck logging date back to a period about 10 years ago when they began to supplant other forms of transportation both for timber and for supplies because of the greater trip speeds and the reduced costs of operation.

The growing interest in the subject in eastern Canada, due to its great economic importance, led the Woodlands Section of the Canadian Pulp and Paper Association to commission Mr. Townsend, an expert logger, to collect and compile the best information obtainable on the subject of motor truck haulage, particularly for winter conditions. The present volume represents the best practice found on the many operations visited throughout the logging regions of eastern Canada and northern United States, east of the Rocky Mountains. The text contains many half-tones and line drawings which illustrate important types of equipment and the road systems which are used by the more successful operators.

The discussions in Part 2, dealing with truck power, sliding and rolling resistance, and grades and curves present concisely and clearly important data much of which, up to this time, has not been available in handy form to the truck logger.

The technique of motor truck logging is still in the evolutionary stage and studies such as Townsend's represent a valuable contribution to the subject. The printed report, which should be in the hands of every motor truck logger, may be obtained from the Woodlands Section.

R. C. Bryant,
Yale School of Forestry.

Waldverbreitungskarte Deutschlands (Forest map of Germany). Compiled under the direction of Franz Heske by R. Torunsky, *112 x 132.5 cm. J. Neumann, Neudamm and Berlin, 1937. Price unmounted, 4 RM; mounted, 10 RM; on rollers, 16 RM.*

This map, on a scale of 1:1,000,000 shows the distribution of forests in great detail. Individual tracts as small as 1

acres or less are shown. No attempt is made to classify the forests, nor does the map show topography or any physical features except the major rivers. The map is accompanied by a brief statement on land utilization in Germany, forest areas by states, and the historical development of forest distribution.

W. N. SPARHAWK.

The Influence of Soil Profile Horizons on Root Distribution of White Pine (*Pinus strobus* L.). By Harold J. Lutz, Joseph B. Ely, Jr., and Silas Little, Jr. *Yale Univ. School of Forestry Bull. 44. 74 pp. Illus. 1937.*

The question which Lutz and his associates attempt to answer is in what soil horizons do the roots of eastern white pine concentrate, and why.

The investigation was carried out on the Yale Demonstration and Research Forest at Keene, N. H. Seventeen profiles were opened under 35-45 year old white pine on various soil types, all belonging to the podzol group. In all, 1,005 square feet of profile were studied. A description and a sketch were made of each profile, and all living white pine roots were recorded on this sketch. Also a description, measurements, and a map were made of the vegetation on each station. Soil samples were taken from each horizon and tests for mechanical analyses, moisture equivalent, total nitrogen, pH, and base exchange properties were made on the samples.

Two bases were used for comparing root distribution in the different horizons: (1) the average number of roots exposed in vertical cross section 10 feet in length, and (2) the average number per square foot of rock-free cross sectional area. The former is a good index of the importance of the horizons from standpoint of tree development, while the latter is useful in comparing the relative favorableness of different horizons for root development.

The largest number of white pine roots occurred, as expected, in the A and B horizons. Only a few were found in the organic layers owing to their thinness—most of the land had formerly been in agricultural use—but the H layer had more roots per square foot than any other horizon and about three times more than the F layer. On the same basis the A horizon (including the organic layers) had nearly eight times as many roots as the B horizon, and this had about ten times as many as the C horizon.

All the soils investigated were sandy and the mechanical composition strongly influenced root distribution. Roots were few or entirely lacking in soil horizons containing 90 per cent or more sand, but were concentrated in fine-textured layers in the substratum. The number of roots in the soil horizons appeared also to be increased by better physical conditions, higher moisture equivalent values, content of organic matter, content of total nitrogen, total exchange capacity, and content of exchangeable bases. No consistent relation between hydrogen ion concentration and root distribution could be established.

The investigation is a valuable contribution, both to forest ecology and to forest soil science. The profile description might perhaps have been a little more clear. It is not always evident to what extent cultivation or pasturing and to what extent natural factors are responsible for the horizons. It is also somewhat confusing when the authors announce that they use Shaw's terminology of 1928 and then use subsoil for substratum. Shaw proposed to call the B horizon the subsoil.

SVEND O. HEIBERG,
New York State College of Forestry.

The Design and Analysis of Factorial Experiments. By F. Yates. *Imperial Bureau of Soil Science (Harpendon, England). Technical Communication 35. 90 pp. 1937. Price 5 shillings.*

The introduction explains the purpose of the publication as follows:

"Factorial experiments are experiments which include all combinations of several sets of treatments or 'factors.' Information is thus simultaneously obtained on the responses to the different factors, and also on the effects of changes in the level of each factor on the responses to the others.

"This Technical Communication has not been written with the object of convincing experimenters of the need for employing factorial designs, but rather for those who, while fully conscious of the advantages of such designs, find difficulty in laying them out and in analysing the results. It is, in fact, an attempt to give a comprehensive survey of the simpler types of design at present available, and a description of the appropriate methods of analysis. The reader who has not done so is advised first to read Professor R. A. Fisher's *Design of Experiments*, where he will find a full account of the logical basis of the whole technique of modern experimental design."

Starting with an experiment on potatoes in which the 8 treatments are made up of combinations of 3 factors at 2 levels each, he proceeds through the case of more factors at 2 levels, to actors at more than 2 levels. Emphasis throughout is placed uoon gain in efficiency through the device of confounding certain effects with blocks. Systems of confounding are presented. The use of dummy treatments, arrangements with split plots, and the Graeco-Latin and higher squares are discussed and illustrated in detail.

The goodly number of research foresters who are acquainted with the principles of the factorial design will find Yates' treatment of the subject simple, comprehensive, and well illustrated with numerical examples. Furthermore, the communication should prove suggestive, to silviculturist and ecologist, of ways and means of gaining efficiency and comprehensiveness in experiments which by their very nature require large plots of timber or range.

F. X. Schumacher,
Duke University.

Increasing Growth and Yield of Young Spruce Pulpwood Stands by Girdling Hardwoods. By Marinus Westveld. *U. S. Dept. Agric. Circ. 431. 19 pp. 4 fig. 1937.*

Every operator is interested in reducing the cost of his pulpwood. For some time girdling has been advanced as a cheap method of forest stand improvement in cut-over mixed stands, where unmerchantable tolerant hardwoods have been left standing. Large areas of the forests in the northeastern states and in eastern Canada, which were cut over many years ago for pulpwood, are in this type. This authoritative circular summarizes the results of girdling defective hardwoods thirty years ago.

In 1905 three one-half acre plots were established at Corbin Park, N. H., in a mixed hardwood-softwood type from which the merchantable soruce had been removed. On two of the plots, some of the hardwoods were girdled, lightly on one plot and moderately on the other. The third plot was left as a control. The girdled plots were treated again in 1915, when 71 per cent of the hardwoods were girdled on one and 90 per cent on the other.

Part of the success of the experiment can probably be attributed to the fact that the stand was not opened up too drastically, but a preliminary girdling of the largest trees prepared the stand for

the rather severe treatment 10 years later. The analysis shows the increment in diameter, height, basal area, merchantable volume, and volume of the total stand. An interesting graph shows the growth in merchantable and total volume of the spruce on each plot by five-year periods (1905-1935). As the spruce was very small when the plots were established, merchantable volume does not show up until 1920, and is still small in 1925. In 1930, however, 25 years after the first girdling, almost half of the volume of spruce on the heavily girdled plot was in the merchantable class, but only about one-third the volume of spruce on the moderately girdled plot was in this class. At the end of the next 5 years two-thirds was merchantable on the heavily girdled plot and less than one-half on the moderately girdled plot.

The heavily girdled area had produced 11 cords per acre of sound merchantable spruce in the 30 years since girdling, as against nearly 5 cords on the moderately girdled, less than ½ cord on the control plot. If good hardwoods are merchantable the superiority of the heavily girdled plot over that of the moderately girdled plot disappears, for moderate girdling shows a total production of 14.2 cords of both hardwoods and softwoods, against 12.8 cords for heavy girdling; the ungirdled plot had only 7 cords, mostly of hardwoods. It is to be noted that the selective character of the girdling has resulted in improvement of the stand independent of species.

The financial aspects of the treatment of these plots are well thought out. Cost of girdling is given as $2.60 and $2 respectively, for the heavily and moderately girdled plots. Although it is quite possible to show that an investment of these amounts will in 40 years yield a handsome profit, even at higher than normal interest rates, this method is not used. Instead, the courses open to an operator who has not a sufficient supply of spruce pulpwood to meet his mill requirements are discussed. It is shown that with profits of $57 and $32, which can be expected from girdling heavily or moderately, it is much cheaper for him to girdle hardwoods and increase the yield of pulpwood on his present holdings than to purchase more forest land in similar condition. Even at the low price of $2 an acre, purchase of 3 to 5 acres represents an expenditure of $6 to $10.

This principle also applies to those large companies whose holdings are large enough to supply all future needs of the mill. A small investment in improving the forest on the more accessible, better growing, and more easily protected part of their holdings may easily result in a greatly reduced cost per cord over wood from inaccessible and less productive districts.

Geo. A. Mulloy,
Dominion Forest Service (Canada).

Wood is Good. By S. Kamesam. *Forest Research Institute, Dehra Dun, U. P., India. 1936-1937.*

This is the general title of a series of pamphlets prepared in the Timber Development Section of the Indian Forest Research Institute. The 18 issued so far include such titles as Wood's *Challenge to Steel and Concrete; Manufacture of Small Dimension Stock as a Rural Industry; The Truth About Fire Hazard in Timber Structures; Treated Wood for Earthquake Resistant Structures; Special Factors Affecting Timber Design; Better and Cheaper Fencing; Treated Timber Bridges for Indian Highways and Railways; Wood versus Steel for Framed Buildings; Fire-proofing of Wood; and Treated Wood for Flooring.*

With these booklets, the Forest Research Institute adds its bit to the efforts of forestry agencies in many countries to popularize and increase the use

of wood. The Institute says: "It is not the intention that wood should be looked upon as the favored and pampered child of wealthy parents. All we ask is that engineers honestly and without prejudice should consider the ideas presented in these booklets, use their own special qualifications to check them up, and give treated timber the same consideration they give to other structural materials. The Forest Research Institute . . . holds that timber can stand on its own merits and in not a few cases it will be found still standing when other materials have fallen."

W. N. SPARHAWK.

On and Off Alaskan Trails. By Dow V. Baxter, Benjamin Labaree, and Willard Hildebrand. *184 pp. Illus. The Ann Arbor Press, Ann Arbor, Michigan. 1937. Price $2.50.*

Those who would recapture some of the pleasurable thrill of their first camping trip will enjoy this book. *On and Off Alaskan Trails* is an expansion of the diary of two students (Labaree and Hildebrand) who accompanied a forestry teacher (Baxter) on an expedition to study Alaskan forests and forest diseases. The party made a leisurely journey by boat along the southeastern coast of Alaska from Ketchikan to Juneau, went inland by automobile from Valdez to Fairbanks and out again by railroad to Mt. McKinley National Park, Matanuska and the Kenai Peninsula. Frequent stops were made to collect specimens, to make photographs and to visit points of interest.

The charm of the book, however, is not in the intentional descriptions of Alaska and its peoples (which sometimes seem to be forced) but in the unintentional, often ingenuous sidelights on the same subjects and more particularly for the memories it recalls of the joyous, carefree days of one's own first venture into the unknown.

RICHARD E. MCARDLE,
Rocky Mountain Forest and Range Exp. Sta.

The Effects of Vegetation on the Growth of Longleaf Pine Seedlings. By L. J. Pessin. *Ecological Monographs 8:115-149. 10 fig. 1938.*

When several investigators work independently on the same problem in different regions and arrive at similar conclusions, there is reason to believe that the findings are mutually corroborative. The gist of Dr. Pessin's findings is that longleaf pine seedlings grow much better where grass is removed than where it is allowed to compete with the young pines. Almost identical conclusions have been reached by the reviewer working with ponderosa pine in Arizona (Jour. For., May 1934), and by Clements, Weaver and Hansen with broadleaf trees in the tall-grass prairies of Nebraska (Plant Competition, Carnegie Inst., 154-197, 1929).

Pessin began his experiment in 1932, employing dense, natural stands of longleaf pine then 12 years old but mostly less than 3 inches tall. Fifteen plots were established, of which seven were denuded of grass and scrub oak but leaving pine seedlings thinned to densities of 1, 5, 10, 15, 25, 50, and 100 thousand per acre; in a parallel series with pines thinned to the same densities, the oak was removed but the grass left; on one plot of 5,000 per acre both grass and oak remained. The grasses were mainly *Panicum* and several species of *Andropogon*.

By 1935 the pines on the denuded plot

of lowest density had grown to an average height of 3.16 feet while those on the grassy plot of the same density were only 0.80 foot tall. On both denuded and grassy plots, height growth decreased with density of pine until, with a stand of 100,000 seedlings per acre, the average height was only 0.31 foot on the denuded and 0.20 foot on the grassy plot. It thus appears that while grass held down the growth of pine seedlings, competition between the pines themselves had a similar though less pronounced effect. The pine seedlings made their poorest growth on the plot on which both grass and oak remained.

The annual precipitation at a station near the plots is around 60 inches. Moisture is so abundant that the author does not regard it as a limiting factor except during one period of 3 months from September 4 to December 4, 1933, when the total rainfall was only 2.96 inches.

Pessin found the soil moisture in the upper 2 inches consistently higher on the grassy than on the denuded plots, but below this depth down to 12 inches there was little difference. During the dry spell of September 4 to December 4, however, the moisture in the root zone between 6 and 12 inches was 1 to 3 per cent higher on the denuded plots. (The Arizona experiment showed a higher moisture content on the grassy plots in the root zone below 4 inches during the early part of the season, but in the dry season of late June and early July the relation was reversed.) In both regions evaporation kept the surface drier where the shade of a grass cover was lacking, but when moisture in the root zone became deficient the shortage was most evident where both grass and pine were drawing it out.

It is difficult to understand why, if moisture is rarely a limiting factor in the longleaf pine forests, growth should be so much more rapid where the grass is eliminated. Evidently the author dismisses light as a possible factor. In Arizona, moisture is the critical factor during intense dry periods, but the shade of the tall grasses is also considered harmful throughout the growing season. Clements, Weaver, and Hansen attribute the adverse effect of tall grass on broadleaf-tree seedlings to competition for moisture and light.

Whatever the explanation, Pessin's experiment leaves no doubt as to the retarding influence of grass on longleaf pine seedlings. European silviculturists have long regarded the subject as settled beyond the need of experimentation; when they plant trees or seeds they chop out the grass. In extensive forest practice in the South as well as in the Southwest it is not practical nor desirable to go to the extreme of removing *all* vegetation that may compete with pine seedlings, but no forester can disregard the basic principles which are the same in forestry as in gardening and farming.

Dr. Pessin is to be complimented on his lucid presentation of data and conclusions. Supplementing the tables and charts is a series of photographs arranged in such manner that they tell the essential part of the story. The publisher deserves credit for the excellent reproduction of photographs.

G. A. PEARSON,
Southwestern Forest and Range Exp. Sta.

Skogshistoriska studier i trakten av Degerfors i Västerbotten. (Forest-Historical Studies in the Degerfors District of the Province of Västerbotten.) By Lars Tirén. *Meddelanden från Statens Skogsförsöksanstalt 30:67-322. 140 fig. (English summary pp. 315-322.) 1937.*

This work may well be described as a study in ethnological forestry for it describes the relation of man and his culture to a specific area of forest over a long period of time.

Beginning with the earliest known peopling of northern Sweden shortly after the retreat of the inland ice sheet about 8,000 years ago, Tirén develops the history of man's life and activities as they affected this particular forest and as the forest influenced them. Using an existing series of forest scientific studies of the region as a background, he undertook a detailed study of man's age-old relationships to what is now Kulbäckslidens Experimental Forest.

In his introduction Tirén says, "These forest studies have led the author to the conclusion that the present condition of the stands is by no means merely an expression of the natural qualities of the locality but that in highest degree it depends also on their historical evolution. The forest at Kulbäcksliden is not an undisturbed virgin forest, as a superficial examination will show. It is, on the contrary, a severely exploited and badly neglected forest remnant. The reproduction has come in following fire, and during youth, when it should have grown most rapidly, has been suppressed by the mother trees, the real primeval forest giants. As a result it has become suppressed, slow growing, lichen-covered, and weak.

"The forest has often had a strong admixture of birch which has contributed to the suppression of reproduction and has given it a threadbare, ragged aspect. Many diseased and otherwise poor trees have, during the whole time, occupied the growing space to the detriment of the development of better types. Over a large territory the best of these have long since fallen before the axe and only the poorer ones are left today. Even the soil itself has, little by little, become deteriorated through deficiency of light, warmth and life giving humus. By degrees it has been brought close to exhaustion. One can almost say that famine exists in the forest."

Step by step, from the very beginning of settlement, Tirén develops with abundant detail the history of this forest. Some of his principal headings are: The Development and Settlement of Population; Fishing and Hunting; Mining; Cattle Breeding, Grazing and Agriculture; Commerce and Trade; Colonization; Forest Fires Before and After the Great Fire of 1694; The Interpretation of Old Charts and Maps of the Forest; The Consequences of Forest Fires and their Relationship to the Development of Forest Stands; Lumbering and Milling; Tar Production; Potash Production. There are analyses of all of the foregoing activities showing their relation to the present condition of the forest.

The study is superbly illustrated with photographs and reproductions of maps and historical documents. These, together with all graphs and tabular material, have titles and explanatory notes in English.

In the opinion of the reviewer, Tirén's work is a model of its kind, complete and satisfying in every detail. It could well be adapted for use by students of forest history and economics. Its organization and framework lend themselves to use in future studies of a similar nature.

R. P. HOLDSWORTH,
Massachusetts State College.

Twig Key to the Deciduous Woody Plants of Eastern North America. By William M. Harlow. *3rd edition, revised. 50 pp. Illus. Published by the Author, New York State Coll. of Forestry, Syracuse, New York, 1937.*

This booklet, now in its third, revised edition, will be found of considerable aid in identifying the deciduous trees and shrubs of eastern North America, during that portion of the year when these plants are normally devoid of leaves. It contains a complete discussion of the twig characteristics of value in identification; a complete and well illustrated key; a list of selected references; a glossary of technical terms; indices to both the common and

scientific names of the species identified in the key. The photographic half-tones of buds and twigs which accompany the key permit a visual comparison with the twig being identified. In some cases groups of closely related plants are not separated. The author points out that such a separation would make the key unwieldy. Moreover, other characteristics are often necessary positively to identify individual members of these groups. A few of the more common exotic species are also included.

The subject matter in this booklet is well adapted to use by amateur botanists as well as by those who have had training in the taxonomy of woody plants. It is recommended to every resident of the territory east of the great plains who wishes to study the deciduous trees and shrubs found growing in his vicinity.

LOUIS W. REES,
University of Minnesota.

Forest Conditions in Hamilton County, Tennessee. By Tennessee Valley Authority Department of Forestry Relations, in cooperation with Hamilton County Regional Planning Commission. *Forestry Bull. 1. iv+ 71 pp., 12 fig. (Mimeographed). 1937.*

The most important wood-using center in the Tennessee Valley is Chattanooga, in Hamilton County, Tenn. Of 234 industrial establishments in and around the city, 50 are primarily dependent on wood as a raw material. In addition, 85 portable sawmills operate in the county. But the wood-using industry appears to face severe adjustments in the near future, owing to the destruction of the forest resource in Hamilton and neighboring counties. This picture is presented in a recent report by the T.V.A. Forestry Relations Department, assisted by the Hamilton County Planning Commission.

Begun in the summer of 1936 and completed in the fall of 1937, the project is an example of T.V.A.'s Regional Study Program, which aims to point out relationships that must be observed if the region is to make full use of its possibilities. An inventory was made of the forest area of the county, with type maps and volume and growth estimates by condition classes. Total drain was determined through a survey of the wood used as industrial raw material, fuel-wood, fencing, poles, etc. Related economic and social considerations are discussed in detail.

The 194,000 forested acres in Hamilton County everywhere show the result of heavy over-cutting by portable mills, some of which take trees down to 5 and 6 inches. It is stated that . . . "the forest resource is reverting to a condition wherein practically all of it soon will be composed of small-sized, non-usable material." In addition to destructive logging, the forests have been impoverished by repeated fire damage, and little is now being done to improve the situation. Only 7 per cent of the growth, or 16 bd. ft., occurs on pines above 9 inches d.b.h. and hardwoods over 13 inches. The study indicates that under proper management the county's forests would be able in time to grow 200 bd. ft. per acre per year in sawtimber, or nearly 40,000 M.B.M. altogether, a yearly harvest equal to the present drain.

The reviewer has seen such small trees cut in the Chattanooga area that loggers were able to carry as many as two sawlogs on their shoulders. Close stripping of the forests, as the report brings out, is typical in other parts of the increasingly industrial Tennessee Valley. There is no warning of a timber famine for such localities, as lumber can be shipped in, though with obvious disadvantages. Some wood-using concerns will move; others will make adjustments on the basis of higher manufacturing costs. The forest problem is one of making lands now

reduced in productivity contribute what they should to the economic well-being of areas in which farm distress, low incomes, and unemployment make it imperative that no source of wealth be allowed to deteriorate and waste.

Foremost among remedial measures discussed is public ownership for certain mountain lands, now more than 50 per cent tax delinquent and of practically no value to the owners or the county. The county is fortunate in that 61,000 acres of these lands have already been proposed for acquisition as part of a National Forest. The T.V.A. expects to acquire a protective strip surrounding the lake formed by the new Chickamauga Dam, and this, together with the possible National Forest purchases, may take care of forest areas where public ownership seems most acutely needed. Most of the remaining forest would be in farm woodlands. Here the problem of bringing about good practices ties in with discouraging factors affecting the rural sections. The need for a long-time program, involving increased public expenditures, is realized. As a beginning, extension of State Forest Service facilities for fire control is stressed, as well as expansion of both state and T.V.A. educational work. Especially noteworthy is the suggestion that a cooperative form of organization be given trial. The cooperative of forest owners would control manufacturing equipment, and through trained men would supervise cutting operations and investigate markets. In general, there is need for owners, private and public, to group themselves into economic units capable of continuous yields.

Several earlier T.V.A. publications have drawn favorable comment for their attractiveness to the non-technical reader. Following the same tradition, this bulletin will be very readable to the layman and should serve to awaken planning agencies and citizens to the need for remedial moves.

Charles R. Ross,
Chattahoochee National Forest.

CORRESPONDENCE

DEAR MR. CHAPMAN:

In connection with the proposed referendum to define standards with relation to National Parks, National Forests and Wilderness Areas, there is one phase in which I am especially interested. I refer to the wilderness or primitive areas. The establishment of primitive areas by the Secretary of Agriculture is certainly a step in the right direction, but I found on visiting some of those areas and in talking with supervisors this past summer that there is a lack of uniformity in the regulations on those areas. Furthermore, since those areas are created by the Secretary of Agriculture there is no assurance that the boundary lines or the regulations now in force may not be discarded by any succeeding secretary. The primitive areas seem to be in the same category as the National Monuments, and in the case of the Olympic National Monument, it will be remembered, that President Wilson cut the area created by President Theodore Roosevelt practically in half.

During the past few years the policy of the National Park Service in relation to the establishment of National Parks seems to have changed very radically, and I believe that certain areas have been approved by their specialists for the creation of National Parks which do not measure up to the standards originally set up for such areas. I refer in particular to the report on Mount Katahdin in Maine, which advised the creation of a National Park in that area. Mount Katahdin is a beautiful mountain, but for the most part the area surrounding it has been cut over and burned over to such an extent that it in no way measures up to National Park standards.

One of the main purposes in the creation of a National Park is to prevent the intrusion of commercial interests. Under the Wallgren bill, which I understand has the full approval of the National Park Service, to enlarge the Mount Olympus National Monument by the creation of a National Park, Lake Crescent and the surrounding country has been included in the bill for the creation of that park. Here is a case where most of the lakeshore is covered with commercial hotels, camps and the lake, and the area to the north has been cut over and burned until there is nothing about it that can be considered primitive. If this policy is to be continued, then it is high time that the beautiful areas now within the National Forests should be given Congressional status which will prevent the extension of inferior National Parks.

I believe that the time has come when a general act providing for wilderness areas should be passed by Congress and that the primitive areas now set aside should be reconsidered and the boundary lines permanently established. No change should then be permitted to take place in those areas, such as mining, lumbering, and the like, or in the boundary lines themselves, without an act of Congress. This procedure would give those areas practically National Park status, and I hope that the Society will take a stand on this matter in the near future.

HARRIS A. REYNOLDS,
Secretary, Massachusetts Forest and Park Association.

Professor Henry Schmitz:

Several of the readers of the Journal of Forestry have recently expressed criticism of the content because it contained many articles of a technical nature of no interest to them. Having read 4 articles, 1 review, some of the correspondence, and the editorial, I have finished my reading of the January issue, and I am quite satisfied with it. I regularly read several scientific and professional publications, and with these I am well satisfied to find any paper that falls in my field of interest. In the January *Industrial and Engineering Chemistry* I am well satisfied with finding 3 articles of interest to me. Had I more time, I would broaden my outlook in both fields by further reading.

G. A. Pearson, in current correspondence, suggests that there is demand for a new publication of greater interest to the general run professional forester than to the scientific forester. There is much merit in the suggestion, but I believe it would be better to change the present Journal to meet that demand and to seek publication in more technical scientific journals of all articles of a highly technical nature. Papers of a technical nature of interest only to foresters would still have to be published in the Journal. Informative articles on findings of our own and foreign forest experiment stations should also be brought to the attention of foresters in this journal. In addition to general forestry papers, a page of professional news and notes, as suggested by De Leon, as well as a *Science News* supplement supplied by Science Service, Inc., might be of interest to all foresters. Then in addition to getting the Journal, if every member would agree to subscribe to *Biological Abstracts*, no doubt this publication would be willing to cooperate with the Society and make available *Biological Abstracts* for about $3 a year. The Society then could make available funds to enlarge the section of forestry abstracts and could assist with the abstracting to cover all American and foreign publications on all phases of forestry and related fields of interest to foresters.

It would seem desirable that foresters generally have at their disposal an abstract journal similar to the one which has meant so much to the chemistry profession. It seems unnecessary at this time to provide a separate journal for forestry alone, and much as the Society might want to establish one, the cost would be prohibitive. With our united support of *Biological Abstracts* and with a coordinated plan for the members to assist in furnishing the abstracts, a section of abstracts covering every phase of forestry could be set up which would be of great value to all foresters. A forester in the woods getting no other publications would know what was going on and would get as much information on the subjects as he would be able to use from the abstracts. The scientific forester would be directed to the journals for more technical information, and he would have better access to the scientific journals than the other foresters.

In conjunction with the desire expressed in your editorial to reestablish the old *esprit de corps* of the forestry profession, may I suggest that it would be worthwhile for the fellows in the field to submit more experiences and stories to the Journal. It is no doubt proper for "easy chair" foresters to keep pumping them full of new technical knowledge, economics, and public opinion, but if we want to keep the spirit of the forester alive in us, if we want to keep our feet rooted beneath the duff of the forest floor, some of the color and glamour of the forest life must creep back into our lives, and it would be an excellent help if some of them could tell us of the things that go on in the woods having no formulated scientific basis and seemingly no connection with economics, but go on just the same.

John M. McMillen.